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TECHNICAL REPORT NO. LWL-CR-04F70

QUIET, SPECIAL-PURPOSE REVOLVER (QSPR) DESIGN IMPROVEMENTS (U)

Final Report

By

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July 1972

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ABSTRACT

(U) The LWL Tunnel Weapon was evaluated in the Republic of Viet Nam during July through October 1969. The results of this evaluation indicated that the weapon system was well received primarily because the low firing noise permitted use of the weapon without giving away the user's position. In addition to its tunnel exploration role, the weapon was used in ambush situations and in search and destroy operations. Because of this, the weapon is now designated the Quiet, Special-Purpose Revolver (QSPR).

(U) Before consideration could be given to quantity procurement, it was necessary to correct any weapon and ammunition deficiencies noted during the RVN evaluation, particularly those reported as ammunition misfires.

(U) The objectives of this program were to determine the causes of misfires and malfunctions of the Quiet, Special-Purpose Revolver and its associated low signature, multi-projectile ammunition; to modify or redesign components to effect necessary corrections including testing of all components to assure reliability of corrective action; and to modify weapons and fabricate ammunition for reliability testing by USALWL.

(U) The effort expended under this contract revealed that the major causes of the misfires were the marginal firing pin energy and the combination anvil-primer design of the ammunition. A secondary or helper spring was added to the weapon's mainspring that provided a 50% increase in firing pin energy and eliminated mainspring degradation. The ammunition was redesigned with fewer parts and the primer was repositioned and exposed at the base of

the round for direct contact by the firing pin as in conventional ammunition. These design improvements resulted in not a single misfire throughout the development, assurance, and acceptance tests associated with this program.

(U) Numerous other design improvements were incorporated into the weapon, ammunition and holster assembly. At the completion of the program, improved weapons, improved holster assemblies, and improved ammunition complete with packaging were delivered for further user tests.

(U) A series of firing tests were conducted by LWL to evaluate the reliability and effectiveness of the QSPR and ammunition. Analyses of the data showed the reliability of the weapon and ammunition to be good at this stage in the development and that the QSPR offers considerable lethality improvement over both the caliber .38 revolver and the caliber .45 pistol inside the ranges of interest.

FOREWORD

(U) This work was conducted for the USA Land Warfare Laboratory under the terms of Contract No. DAAD05-70-C-0270. This report relates all efforts authorized under the terms of this contract. The task performed under the basic contract was to determine the causes of ammunition misfires and malfunctions and to effect remedial action to eliminate same. A modification of the basic contract included the fabrication and testing of various barrel configurations to yield the optimum ballistic dispersion. A further contract modification provided for fabrication of additional weapons and holsters and modification of existing weapons and ammunition.

(U) Tasks No. 5, 6 and 8 of Contract No. DAAD05-71-C-0270 provided environmental tests, corrective rework, additional environmental tests and corrective rework of remaining QSPR ammunition.

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I.(C) DISCUSSION

(U) A. Background

(U) The Quiet, Special-Purpose Revolver (QSPR) is a balanced, compact, six-shot, cylinder-loaded, exposed-hammer, selective-double-action, modified Smith and Wesson .44 Magnum revolver. It fires a special cartridge containing 15 high density pellets at a sound level comparable to the silenced .22 caliber pistol. This multipellet cartridge improves its effectiveness since the shot pattern is similar to that of a shotgun. Its low signature characteristic coupled with its high density multi-projectile capability render it highly effective in quick response, close-in tactical situations.

(U) This weapon system was evaluated in the Republic of Viet Nam during July through October 1969. The results of this evaluation indicated that the weapon system was well received, primarily because the low firing noise permitted use of the weapon without giving away the user's position. Its multi-pellet cartridge afforded effective fire capability in those situations where there was no time for point or aim fire and was thus found to be ideally suited for ambushes. Respondents particularly liked to use the weapon when bunkers, houses and spider holes were encountered on search and destroy operations. Its small size enabled them to reach quickly around corners and fire without exposing more than a hand and arm. This capability had a beneficial psychological effect on respondents, and they reported it was possible to clear such areas much more rapidly with the

QSPR than with a rifle. Several comments were reported that this weapon system would be ideally suited as a survival weapon for aircrews and Special Forces personnel.

(U) Before consideration could be given to quantity procurement, it was necessary to correct any weapon and ammunition deficiencies noted during the RVN evaluation, particularly those reported as ammunition misfires. In addition, numerous user comments regarding possible improvements to the system were worthy of consideration.

(U) The objectives of this program were to determine the causes of ammunition misfires and malfunctions; to modify or redesign components to effect necessary corrections including testing of all components to assure reliability of corrective action; and to modify weapons and fabricate ammunition for reliability testing by USALWL. The program was divided into three phases.

(U) Phase I included the design evaluation to determine the causes of the ammunition misfires and malfunctions and to effect remedial action to eliminate same. Other design considerations were directed toward improved ammunition sealing techniques, improved weapon and ammunition protective finishes, an improved holster and cartridge carrier design, improved lethality capability of the ammunition and the addition of a lanyard retaining ring to the weapon. At the conclusion of Phase I, 200 improved rounds were fabricated and test fired for design assurance tests.

(U) Phase II included the fabrication of 1125 additional rounds, 125 for final acceptance test firings at this contractor's facility, and 1000 for final delivery to USALWL.

(U) Phase III included the fabrication, test and evaluation of three barrel configurations to establish the optimum design for the desired ballistic dispersion.

(U) An extended scope of work was provided to fabricate additional weapons and holsters and to perform design alteration and rework of weapons and ammunition after USALWL reliability tests revealed malfunctions. After correction of these deficiencies, samples of ammunition and weapons were subjected to environmental tests. The presence of moisture in the ammunition indicated additional waterproofing to be necessary. The correction was made and verified by additional environmental tests. The balance of ammunition on hand was then corrected and delivered to the USALWL.

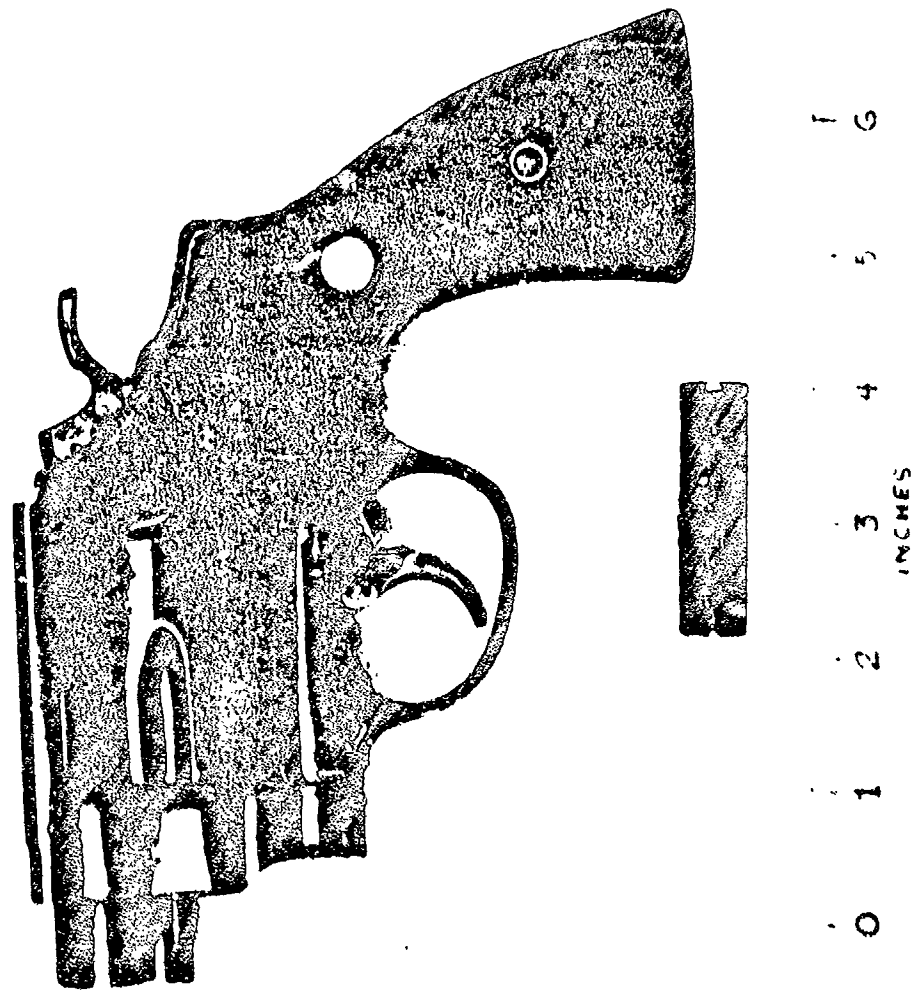
(U) Following is a detailed discussion of the weapon systems deficiencies revealed as a result of the effort expended under the contract, along with the resulting design improvements. Those improvements associated with the revolver, ammunition and holster are presented respectively along with a discussion on lethality investigations and a section including test data.

(U) B. Revolver Evaluation and Design Improvements

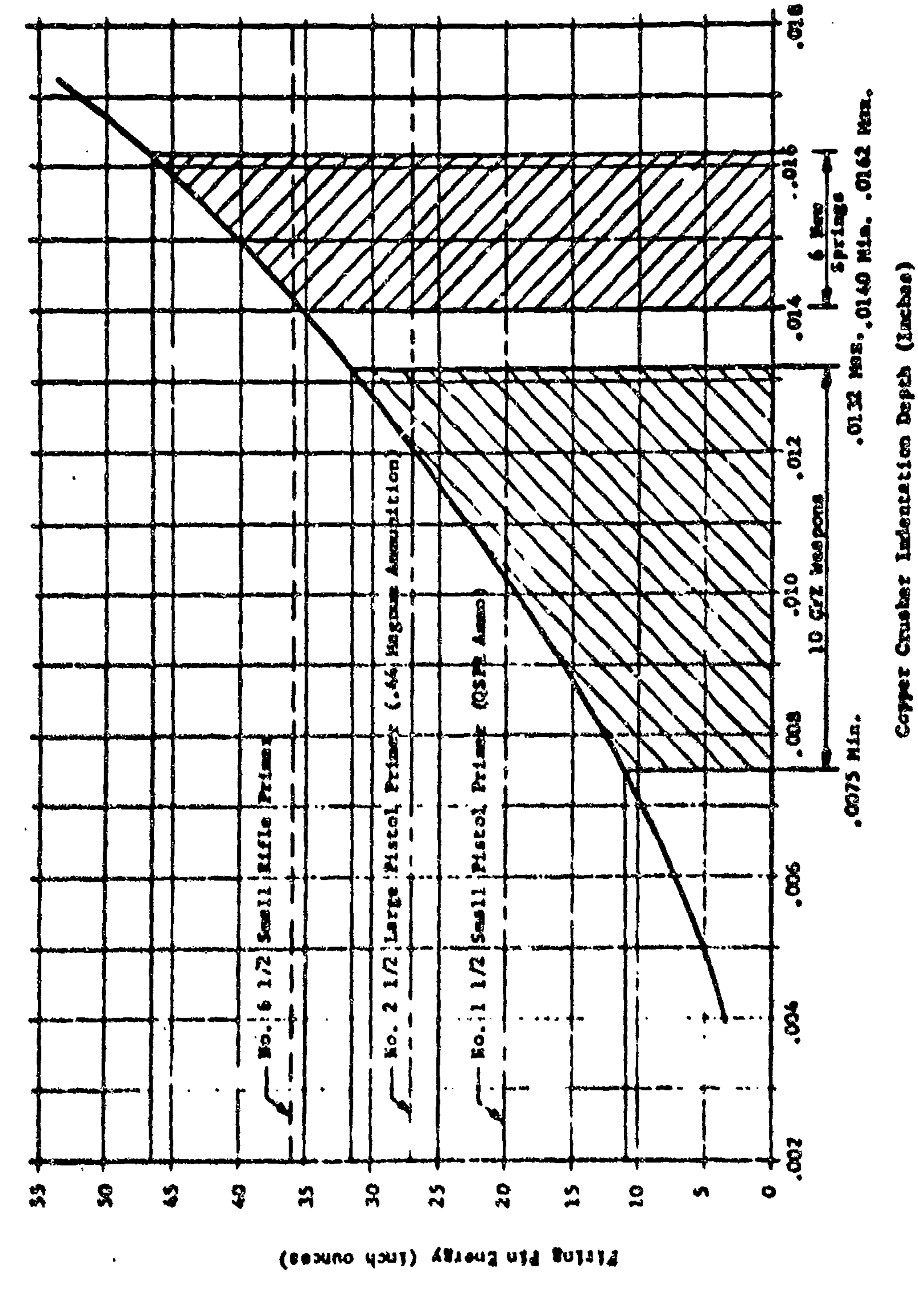
(U) Ten CFP Weapons (Modified Smith and Wesson .44 magnum revolvers), Figure 1, were carefully examined to ascertain any obvious faults or discrepancies as a result of manufacture, assembly, or use in the field, that may have contributed to ammunition misfires experienced during the RVN evaluation. Considerable mushrooming of the firing pin was quite evident and consequently the firing pin protrusion above the breech face was significantly under tolerance. In addition, brinelling of the weapon's frame at the

breech face existed on all ten weapons as a result of round setback forces. It was further observed that the mainspring tensioning screw was not seated on all ten weapons, but had either become loose or was backed out intentionally to achieve a lower trigger pull. The backing off of this spring tensioning screw would significantly degrade firing pin energy.

(U) The available firing pin energy was measured for each weapon with the aid of a simulated round, copper crushers and an original Smith and Wesson firing pin. The mainspring tensioning screw was fully seated in all cases and a muzzle-up weapon orientation was employed since this orientation yielded the least copper crusher indentation depth and represented the minimum energy level. Similarly, the double action mode of weapon operation was also employed exclusively. The minimum and maximum copper crusher indentation depths recorded for the ten weapons, Figure 2, correspond to firing pin energy levels of 11.0 and 31.5 inch ounces respectively. Also indicated is the manufacturer's energy requirement to reliably fire the No. 1 1/2 small pistol primer (used in the existing ammunition) and the No. 2 1/2 large pistol primer (used in standard .44 magnum ammunition). It became quite obvious that some of the weapons exhibited firing pin energies considerably below that required to reliably fire the No. 1 1/2 primer, even with the mainspring tensioning screw fully seated, and neglecting the additional energy loss absorbed in accelerating the anvil into the primer. (See section on ammunition). It therefore became reasonable to assume that these low firing pin energy levels could have been responsible for ammunition misfires, particularly, if the mainspring tensioning screw had been backed out to achieve a lower trigger pu''



(U) FIGURE : . QUIET, SPECIAL PURPOSE REVOLVER (QSPR)



(U) FIGURE 2 - COPPER CRUSHER INDENTATION DEPTHS VERSUS FIRING PIN ENERGY FOR 10 GFP WEAPONS AND 6 NEW MAINSPRINGS

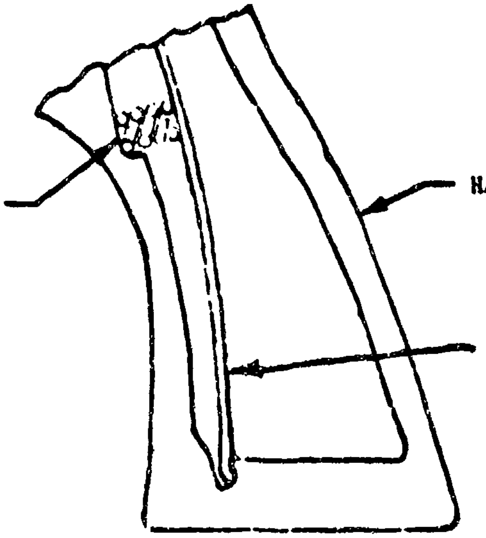
(U) New unused mainsprings were secured from Smith and Wesson and energy levels were recorded for six of them, in a single weapon, and under identical conditions as before. These values are also presented in Figure 2. Note that the significantly higher energies from these new springs all exceed the energy requirements for the large pistol primer. It was concluded at this point that the mainsprings in the ten GFP weapons had definitely experienced a degradation. It was further theorized that severe hammer rebound could cause this detrimental effect by exercising the spring at an extremely high rate. Hammer rebound was known to be prevalent because of the reversing action of the anvil within the round itself. At the onset of firing, the anvil is first driven forward into the primer by the impact of the firing pin. Upon round initiation the anvil is then thrust rearward to its initial static position. It is this rearward movement of the anvil against the firing pin that is responsible for the hammer rebound phenomena. Subsequent high speed motion pictures of the mainspring and hammer movements during firing substantiated that the hammer rebounds all the way back in .003 seconds and impacts the weapon frame. However, when compared to the .243 inches of spring travel, a spring velocity of 6.5 feet per second was realized. Thus, it became obvious that the spring velocity during hammer rebound was relatively low, and not a significant factor in spring degradation. It was further observed, however, that noticeable spring oscillation occurred after the hammer impacted the weapon's frame. It is believed that these oscillations occur as a result of the kinetic energy remaining in the spring after the hammer has impacted the frame.

(U) Concurrent analytical studies indicated that fully seating the spring tensioning screw resulted in such a high initial pre-load, that the

spring was being stressed beyond its yield point when the hammer is fully cocked against the frame (point of maximum spring deflection). These analytical results were subsequently verified experimentally. Three new unused mainsprings were individually installed, again in a single weapon with spring tensioning screw fully seated, and dry cycled by hand cocking the hammer until it contacted the frame 100 times each. Energy measurement, both before and after cycling, indicated the firing pin energies of these three springs were degraded 18.5%., 23.0%, and 37.0%, respectively. Thus, it was concluded that a portion of the energy loss experienced in the ten GFP weapons can be correlated to the fact that the springs were overstressed initially. Furthermore, additional stresses induced into the spring due to hammer rebound (as computed from motion characteristics observed from the high speed motion pictures) could have had a further progressive degrading effect.

(U) Continued experimentation revealed that if the spring tensioning screw was restricted such that the springs were not overstressed initially, then no energy degradation occurred due to dry cycling. However, in so doing, the available firing pin energy was of the magnitude of 22.5 inch ounces, and afforded little excess of the 20 inch ounces required to reliably fire the No. 1 1/2 primer. Such a small safety factor on firing pin energy was considered incompatible with the primary objective of this program, namely to increase round functioning reliability by eliminating misfires.

(U) Consequently, a dual spring installation was designed consisting of the original mainspring with limited preload so as not to be overstressed, and an additional small compression spring placed between the mainspring and weapon handgrip frame as shown on the following page. The resulting firing pin energy of 34.0 inch ounces, attributable to this secondary or helper spring,



represents a 30% energy increase and effectively provides a significant safety factor over the 20 inch ounces required. Subsequent monitoring of this improved dual spring installation through repeated dry cycling and actual live firing tests revealed no spring energy degradation whatsoever. Also of extreme importance is the fact that not a single misfire occurred throughout this program with the advent of the dual spring installation and other ammunition design improvements discussed later in this report.

(U) Two GFP weapons were modified to accept this dual spring installation. At the same time, a hardened steel insert was installed in the breech face on one of them, to prevent brinelling due to round setback forces. Concurrent ammunition improvements permitted the removal of the mushroomed firing pins and these were replaced with standard Smith and Wesson firing pins (See section on ammunition). Early testing with the increased firing pin energy produced a few minor primer punctures, necessitating a slight reduction in firing pin protrusion and end radius configuration. These two modified weapons, designated as a primary and secondary weapon, were used for all subsequent development and assurance tests. A few weapon problems arose during the

assurance test of 200 rounds but were subsequently corrected. These problems are fully discussed in Appendix B.

(U) Various protective finishes for the weapon were investigated to improve the corrosion and wear resistance afforded by the existing weapon blueing. A black Teflon-S* coating was selected as the most promising and this finish was applied to all internal and external surfaces of a .38 special revolver (not associated with this program) for evaluation. Teflon-S* is a non-stick, self-lubricating, easy to clean, rust resistant, protective finish, first applied and subsequently cured by oven baking. Evaluation of this finish included weapon test firings, and subjection to corrosion inducing environments. The Teflon-S* coating was remarkably easy to clean and exhibited superior rust prevention qualities as opposed to other revolver finishes. Thus, the Teflon-S* coating was selected as the improved protective finish for the Quiet, Special-Purpose Revolver.

(U) At the conclusion of this basic program, four new weapons were procured from Smith and Wesson and remade into Quiet, Special Purpose Revolvers. In addition to all modifications previously required, the four new weapons contained the following design improvements:

1. a .562 inch diameter hardened steel insert recessed in the breech face to preclude brinelling due to round setback forces.
2. a heat treated hand pin and hammer pivot pin.
3. a modified firing pin length and end radius.

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* Registered DuPont Trademark

4. a secondary or helper spring along with the weapon's mainspring to increase firing pin energy.

5. mainspring tensioning screw pinned in place to preclude firing pin energy adjustment.

6. a lanyard retaining ring located in the hand grip butt.

7. a .400 inch diameter straight bore barrel.

8. an improved dull black Teflon-S* protective finish.

(U) These additional modifications were a direct result of weapon improvements evaluated during this program and were considered to satisfy all program objectives. The four new weapons were used exclusively at the end of the program for weapon and ammunition acceptance tests, without incident, prior to final delivery. The straight bore barrel was selected during acceptance tests for improved ballistic dispersion. This is more fully documented in the test section of this report.

(U) Delivery of the four weapons to the Government and their subsequent test firings revealed the following problem areas:

- Excessive wear between the mating surfaces of the cylinder and the cylinder mounting yoke,
- Revolver side plate screws loosening during firing, and
- Difficulty in functioning the weapon due to ammunition interference during cylinder rotation.

(U) A contract modification was awarded to provide corrective measures for the above problems, incorporate these corrections into the four QSPR weapons tested and fabricate two new QSPR weapons to the revised configuration.

(U) Inspection of the four QSPR weapons revealed that upon firing, the recoil of the cylinder is transmitted into the weapon thru a small bearing

area on the cylinder mounting yoke. This bearing area, though adequate for the standard .44 magnum ammunition, was excessively worn due to the combined recoil of firing the QSPR ammunition and the subsequent forward load transmitted thru the cylinder by stopping the piston inside the ammunition.

(U) The result of this wear is excessive clearance in the forward and aft location of the cylinder. This movement is thought to contribute greatly to the difficulty in functioning the weapon due to ammunition interference during cylinder rotation.

(U) Correction of this wear problem was accomplished by machining off the existing bearing surfaces on the cylinder and mounting yoke and adding a hardened steel washer of larger diameter such that the new bearing area is approximately tripled. Subsequent test firings have demonstrated the success of this modification.

(U) The loosening of the weapon side plate screws during firing was thought to be caused by decreased friction due to the addition of the Teflon-S* protective finish. The correction of this problem was accomplished by using screws with nylon inserts in the threads. These inserts provide a locking effect which prevented any subsequent loosening during test firings.

(U) The difficulty in functioning the weapon due to ammunition interference during cylinder rotation was thought to be predominantly caused by the cylinder and cylinder mounting yoke wear problem. An additional weapon modification was made however to further assure elimination of the problem.

(U) An improved surface bevel at the rear of the barrel was added so that, as the next round of ammunition was advanced into the firing position

by cylinder rotation, there would be no sharp corners to cause any resistance.

(U) In addition to all modifications to a standard Smith and Wesson .44 Magnum pistol previously required, the following design improvements were thus made to yield the completed QSPR weapon under the scope of this contract modification.

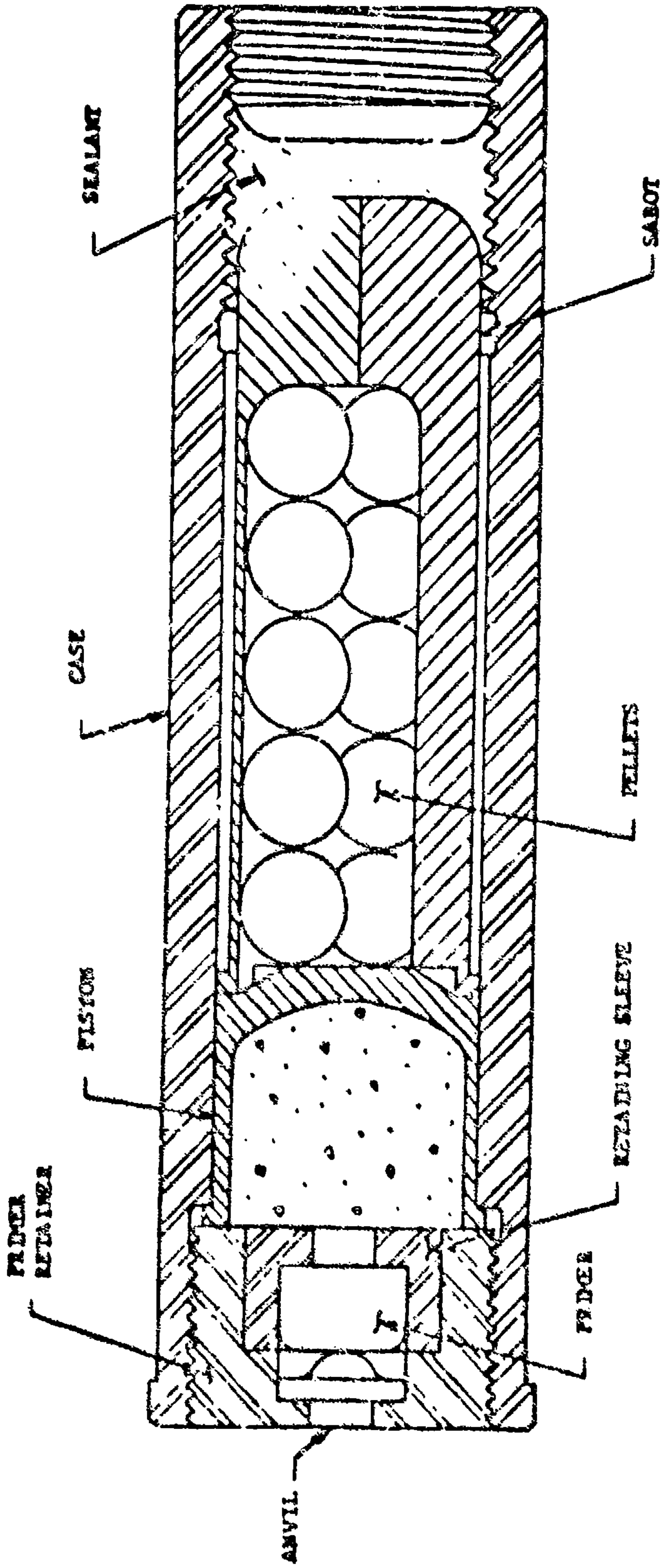
1. Addition of a hardened steel washer between cylinder and yoke to provide increased bearing surfaces.
2. Addition of nylon inserts in the side plate screws to prevent loosening during firing.
3. Improved surface bevel at the rear of the barrel for smooth rotation of the cartridge.

Four improved and two new QSPR weapons were delivered to the Government.

(U) Task Number 5 of Contract No. DAAD05-71-C-0270 provided for environmental conditioning of QSPR weapon and ammunition. Inspection and tests of the conditioned weapon revealed no malfunctions. Appendix "E" contains details of the environmental conditioning of the QSPR weapon.

C. Ammunition Evaluation and Design Improvements

(U) The existing engineering drawings of the ammunition were carefully surveyed with regard to tolerance build-up, press fits, ease of assembly and reliable functioning. One area worthy of consideration with regard to misfires is in the primer retainer assembly (See Figure 3). As then designed, in the extreme case, the anvil could project into the pr[illegible] as much as .011 inches, even after the primer had been consolidated as much as .011 inches. A possible over-consolidation of the primer could have a desensitizing effect and attribute to malfunctions or misfires. Forty-seven CFP rounds of ammunition, designated as misfires from the RVN evaluation, were evaluated by radiography to ascertain any obvious faults or discrepancies as a result of



(U) FIGURE 3 AMMUNITION DESIGN AS EVALUATED IN RVN

manufacture or assembly. Examination of the X-rays proved negative, in fact, no appreciable movement of the anvil could be detected. This observation tended to support the theory that the staking lacquer used around the anvil, when allowed to amply cure for several months, could conceivably prevent or retard the anvil's forward movement into the primer and thus absorb most of the available firing pin energy. To check this, primer sensitivity tests were conducted on fifteen unused rounds returned from Viet Nam. The primer assemblies were removed from the rounds, placed in a test fixture, and subjected to a firing pin energy of 20 inch ounces, the manufacturer's recommendation to reliably fire the No. 1 1/2 small pistol primer. All fifteen primers functioned on the first impact even though the firing pin penetration was varied from .045 inches to .030 inches. Although this relatively small sampling was recognized, it became evident at this point that the staking lacquer was not the primary reason for the misfires. Fifteen primer assemblies identified as misfires, were then subjected to the same test with twelve primers functioning and three primers not functioning. The three primers that did not function were each subjected to a second and third impact, again without functioning, although the anvil had moved forward approximately .020 inches in all three cases.

(U) Considerable emphasis was directed toward an ammunition redesign that would simplify assembly and at the same time increase reliability. The most direct approach was to eliminate the anvil in its entirety, and thus eliminate all of its associated problems. These included (1) an undesirable length over diameter (L/D) ratio that facilitated cocking or canting as the

anvil is driven forward, (2) the undesirable loss of firing pin energy that the anvil absorbed during acceleration, and (3) the detrimental mushrooming effect the anvil produced on the firing pin. It was further concluded that if the primer were inserted from the rear into the threaded base plug, and retained from blow-out due to internal pressures with a crimp, then not only the anvil, but another closely toleranced part could be eliminated as well, namely the retaining sleeve. Furthermore, by so doing, the firing pin would contact the relatively soft primer directly as in conventional ammunition, the mushrooming of the firing pin would be eliminated, and increased reliability would result.

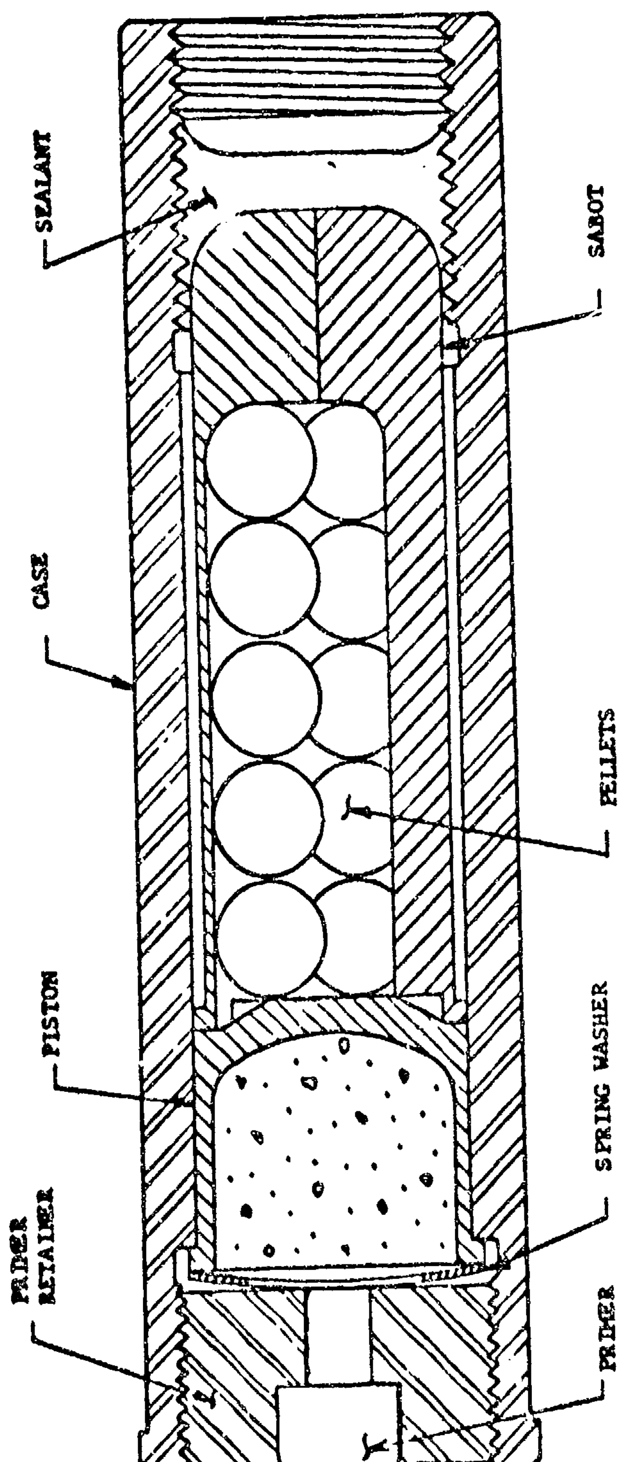
(U) This reasoning led to the development of the redesigned primer installation, henceforth referred to as an improved exposed primer round configuration. A reassessment of the loads in the base plug of the round indicated that heat treatment was not necessary. After a thorough materials search, the maraging steel that was currently used for the base plug was selected, but in the annealed condition. Strength, corrosion resistance and elongation properties dictated this selection. Associated tooling was prepared and various crimping flange configurations were fabricated and subsequently subjected to static tests. The annealed maraging steel crimped exceedingly well and exhibited no evidence of cracking. The most promising configuration was test fired and feasibility was demonstrated when the crimp successfully captivated the primer against all internal pressures and the primer did not blow through when indented directly by the firing pin. A small rifle primer was employed initially because of its increased material

thickness. Reliability data was being sought when a primer blow-through occurred on the 10th and 11th test firings, which also included a 10% propellant over-charge by weight. One out of two subsequent test firings with the standard propellant charge also produced a primer blow-through. Examination of the standard charge round that contained the primer failure revealed that not onl had the primer extruded up flush with the top of the crimped surface, as was customary, but had actually extruded around on top of the crimped surface (between the crimped surface and breech face). Up to this time, the base plug was being threaded into the cartridge case until the primer crimp surface was flush or as below flush as practical. It was therefore decided to back the threaded base plug out until the primer crimp surface was always above the base of the cartridge case, assuring direct bearing against the breech face at round setback. This approach was henceforth used exclusively with complete success including test firings with 10% propellant overcharges. The No. 1 1/2 small pistol primer was subsequently repeatedly test fired without any primer failures. This was considered a big breakthrough with regard to weapon firing pin energy requirements, for now the weapon need only to consistently deliver in excess of the 20 inch ounces to reliably fire the No. 1 1/2 primer, rather than energies in excess of the 36 inch ounces to reliably fire the No. 6 1/2 small rifle primer.

(U) Consequently, this improved exposed primer round configuration, shown in Figure 4, was employed throughout the remainder of this program, and coupled with weapon improvements previously discussed, resulted in not a single misfire, the primary objective of this program. Additional

refinement entailed the inclusion of a curved spring washer, also shown in Figure 4 to keep the piston in intimate contact with the payload, now that the threaded base plug was not positioned against the piston. Improved assembly techniques were devised that facilitated round assembly while consistently positioning the crimped surface of the threaded base plug a known distance above the base of the cartridge case. The assembly fixture was modified to accept a dial indicator and a total tolerance on round overall length of .004 inches was found to be practical. This variation coupled with a total tolerance of the cartridge case of .005 inches, resulted in a tolerance of the crimp projection above the cartridge case of .009 inches. The overall length of the round was fixed a 1.866 ± .002 inches and the length of the cartridge case was reduced slightly to yield a crimp projection above the cartridge case of .006 to .015 inches. Also, the more closely controlled overall round length (.004 inches) associated with a more closely controlled dimension on the weapon, from breech face to aft face of barrel, (.002 inches) permitted a reduction in head space. This closer controlled head space of from .003 to .009 inches further inhanced reliability and significantly reduced hammer rebound to one half of its allowable stroke, as evidenced by high speed motion pictures.

(U) Improved cartridge sealing at both ends was investigated and as a result, no significant change was made in the sealant used at the sabot end of the cartridge except for color. However, an improved sealant was selected for the threaded base of the cartridge. The basic requirements for an effective sealant at the sabot end of the cartridge were summarized as follows:



(U) FIGURE 4 - IMPROVED QCPR AMMUNITION CONFIGURATION (EXPOSED PRIMER)

1. must be self leveling type potting compound that will flow and fill up the voids in and around the sabot and stopping threads.

2. must cure in the presence of moisture and air to an elastic solid that is both heat and water resistant.

3. must not harden to the point when it becomes brittle and susceptible to cracking.

4. should be a one part pre-mixed compound with unlimited pot life.

The white RTV-112 Silicone Rubber used previously was found to possess all of the aforementioned qualities. Examination of the sealant on all of the returned GFP rounds revealed the sealant to be in excellent condition and water immersion tests produced no visible deterioration of the sealant. Research revealed numerous higher strength RTV's but none were found possessing the self-leveling quality. Consequently, the same white RTV-112 Silicone Rubber was utilized on one half of the design assurance test rounds, and a similar clear or translucent RTV-118 Silicone Rubber was utilized on the remaining half of the test rounds (See Appendix B). Since no appreciable difference on round performance could be detected, the clear RTV-118 was selected as the final choice for the sealant at the sabot end of the cartridge, because of its more subdued color and compatibility with the improved cartridge finish.

(U) Examination of the RTV-106 sealant used on the threaded primer retainer at the base of the cartridge case on the returned GFP rounds indicated an effective cure had not been achieved, as evidenced by the low torque required for removal. This was attributable to the fact that the

RTV-106 requires a moisture laden environment to cure. Therefore, an anaerobic type sealant (one that cures in the absence of air) which would positively secure the threaded base plug from rotation when properly applied and cured, was sought. Loctite Retaining Compound No. 1886 provided the answer, not only because of its anaerobic qualities, but also because of its known compatibility with M-9 double base propellant. Component assembly with this compound and subsequent efforts toward disassembly verified its retaining capabilities, and firing tests demonstrated its sealing characteristics. Some outgassing was noticeable around the threads on an occasional round immediately after firing, however, this was not considered objectionable, did not degrade performance, and was no more serious than the occasional gas leak experienced at the piston end of the round. Therefore, Loctite Retaining Compound No. 1886 was selected and utilized exclusively as the improved sealant at the threaded base of the round. In addition, both threaded surfaces were pre-primed with Locquic Primer Grade T prior to the Loctite 1886 application in order to re-activate the surfaces after black chrome plating.

(U) Numerous protective finishes for the ammunition were investigated from a cost effectiveness point of view and the most promising candidate finishes were then subjected to Salt/Humidity Environmental Comparison Tests. Sample cartridge cases treated with each finish were immersed for two minutes in a 20% solution of Sodium Chloride and water, placed in a humidity chamber at 100°F and 95-100% relative humidity for 4 hours, removed and rinsed in fresh water and returned to the same chamber environment for approximately

120 hours. The specific protective finishes under consideration included black chrome plating applied both over the base metal and gray electroless nickel, gray electroless nickel plating, black electroless nickel plating, various oxide finishes imposed during heat treatment, and bright bare metal. These test specimens were then compared and rated with regard to their corrosion resistant qualities. The results indicated that the black chrome plating applied directly to the base metal afforded the most corrosion protection for the least cost, and therefore was selected as the improved protective finish for the QSPR ammunition.

(U) At the conclusion of the development phase of this program, two hundred improved rounds were fabricated for assurance tests. Upon successful completion of these tests, 1125 additional rounds were fabricated, of which 125 were subjected to final acceptance tests and the remaining 1000 rounds were delivered complete with packaging. All of these newly fabricated rounds contained the following design improvements:

1. an exposed, crimped-in-place primer positioned at the base of the round permitting direct contact with the weapon's firing pin.

2. the elimination of two parts and their associated pressed and sliding fits, namely the anvil and retaining sleeve.

3. a practical assembly technique facilitating a more closely controlled round overall length (permits reduced head space).

4. the use of a clear sealant at the sabot end of the cartridge, namely RTV-118 Silicone Rubber.

5. the use of an improved thread sealant at the base of the round, namely Loctite Retaining Compound No. 1886.

6. the addition of a curved spring washer to keep the piston regardless of tolerance variations.

7. a dull black chrome plating applied to the external surfaces of the round.

All of the aforementioned design changes were a direct result of ammunition improvements evaluated during this program, and the resulting increase in reliability over the original configuration satisfied all program objectives.

(U) Delivery of the 1000 rounds was made on 23 December, 1970. Contract modification No. P00008, dated 10 March, 1971 was received and work was immediately initiated to accomplish design alterations on the ammunition to correct problems found in the Governments preliminary testing.

(U) Primer crimp failures on the newly redesigned primer retainer were experienced upon firing. This resulted in the primer being pushed out by internal pressure, jamming the ammunition in the chamber and prevention of the weapon cylinder rotation. No failures of this type had been experienced in the development of this design or the lot acceptance tests.

(U) The reason for the material failure was determined to be the stress corrosion cracking characteristics of the maraging steel used in primer retainer fabrication. Stress corrosion cracking refers to greatly accelerated corrosion that takes place in certain environments when metals contain certain internal tensil stresses. Depending on the conditions stress corrosion failures can take place from within a few hours to many months. AAI testing of the ammunition had always taken place within two weeks of fabrication while Government tests were made after several months of storage. The internal stresses present in the material as a result of crimping and the fact that a certain amount of

time was required before failure indicates stress corrosion cracking to be the cause of the crimp failures.

(U) An improved primer retainer was designed for the ammunition that alleviated the stress corrosion problems encountered with the primer crimp. The exposed primer configuration permitting direct contact with the firing pin was maintained, however, the crimp or swaging operation associated with the stress corrosion cracking of the maraging steel was eliminated in its entirety. Twenty (20) primer retainers reflecting this improved design were manufactured and subsequently assembled into twenty GFP rounds of QSPR ammunition, after removal of their existing primer retainers. Development test firings were conducted, in the presence of the Project Officer, to establish the integrity of this redesign. All twenty rounds functioned normally and cylinder rotation problems experienced previously were noticeably non existent.

(U) Figure 5 shows this new round with the redesigned primer retainer. The exposed primer configuration was maintained, however, the primer is pressed into the retainer and then backed up by a threaded restraining sleeve.

(U) Based on the successful performance of this design change, manufacturing was initiated for additional primer retainers for the remaining rounds.

(U) The existing assembly fixture was modified to facilitate the safe disassembly of the old primer retainer assemblies from the GFP rounds. New primer retainers were assembled and installed in the cases. Assembled lengths as well as sealing techniques were maintained the same as the crimped retainer design.

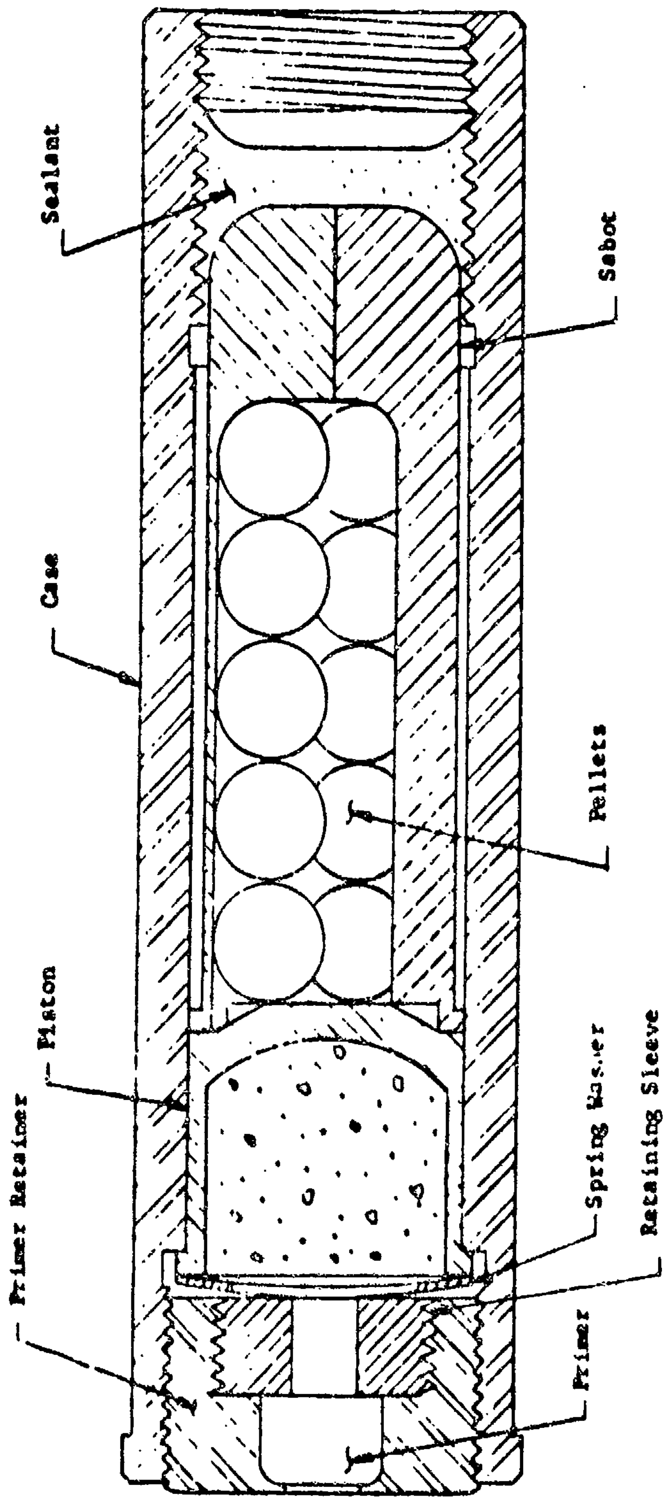


FIGURE 5

(U) QSPR AMMUNITION WITH REDESIGNED PRIMER RETAINER

(U) Prior to delivery of reworked rounds acceptance tests were conducted including three "proof" tests. The results of these tests are given in Appendix "D" of this report.

(U) In assessing the accumulated test results up to this point, it became apparent that the velocities were somewhat lower than those previously recorded when this lot of ammunition was originally acceptance test fired. This velocity decay is difficult to explain since the propellant charge within the round itself was not disturbed in any way during rework, and numerous precautions were employed to prevent moisture accumulation during the short interval the rounds were unassembled. Three of the reworked rounds were disassembled, and the moisture content of their propellant charge was determined to be .23%. This compares to a moisture content of .29% for the same lot of propellant that had been stored in a magazine. These same three rounds were then reloaded with the new propellant from the magazine, and subsequently test fired with no significant improvement in velocity.

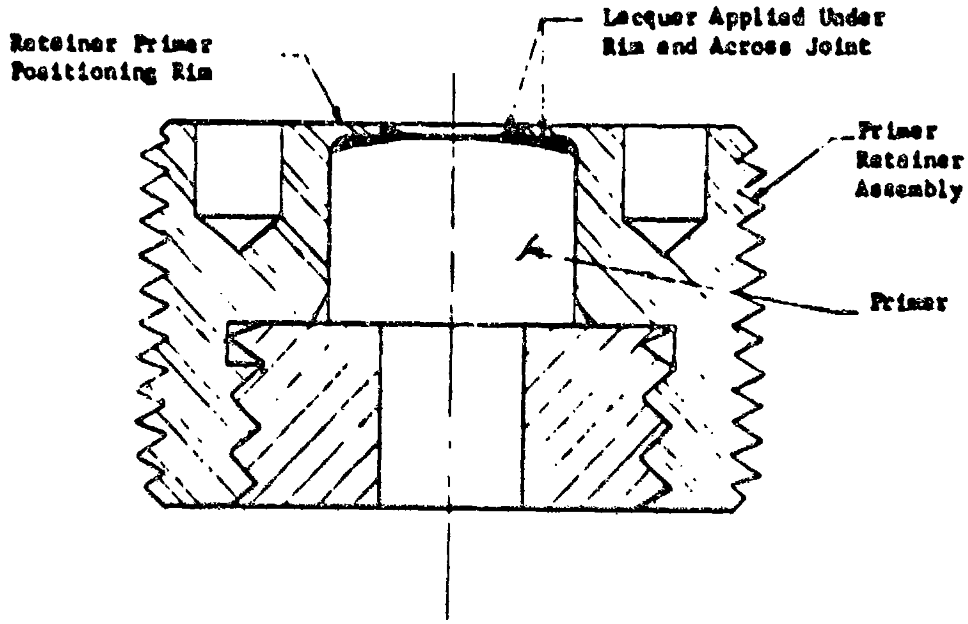
(U) Continued assessment of the velocity decay problem centered around the addition of a screwdriver slot on the retaining sleeve in the redesigned primer retainer assembly. This slot represents a nominal 4% increase in the initial volume of the propellant burning chamber. To more closely observe the effect of this volume change on round performance, three additional rounds were disassembled and reassembled with one primer retainer that did not contain the screwdriver slot. These rounds were fired and exhibited some increase in average velocity. Due to the small sample size involved (three rounds) the decrease in velocity due to increased initial vumume could not be proven conclusively, however, the results indicate that it was a major factor.

(U) Though a slight average velocity decrease was experienced, no significant loss in performance was expected therefore the ammunition was accepted by and delivered to the Government.

(U) Task Number 5 of Contract No. DAAD05-71-C-0270 was provided to conduct environmental conditioning of two hundred (200) improved rounds of QSPR ammunition. Appendix "E" includes a test report certification of the conditioning. The ammunition was then delivered to the Government.

(U) Tests of the conditioned rounds revealed a substantial reduction in performance which was attributed to moisture entry in the propellant and primer area of the ammunition. Task Number 6 of Contract No. DAAD05-71-C-0270 was entered into to correct the moisture entry problem and conduct additional environmental conditioning of seventy-five (75) corrected rounds of QSPR ammunition.

(U) Improvements in the sealing around the primer were thought to be sufficient to correct the problem. The original technique for sealing was accomplished by application of lacquer after the primer was pressed into place against the locating rim on the primer retainer. To improve the seal in this area the lacquer was applied just before the primer was pressed against the rim. This allowed lacquer to flow around the end of the primer and provide sealant between the primer and rim as well as on the exposed joint between the primer and primer retainer rim. Figure 6 shows the location of the lacquer sealant in the corrected design.



(U) IMPROVED PRIMER SEALING TECHNIQUE

FIGURE 6

(U) Primer retainer assemblies were fabricated using the improved sealing technique and seventy-five (75) were subjected to environmental conditioning as outlined in the test report in Appendix "F". Test firings by the Government of these conditioned rounds revealed no further problems with the corrected ammunition.

(U) Task Number 8 of Contract Number DAAD05-71-C-0270 was provided to correct the remainder of the rounds delivered to the Government. The resulting delivery of rounds of packaged, reworked QSPR ammunition was made after acceptance test firings were made.

(U) D. Holster Evaluation and Design Improvements

(U) The 10 used GFP holster and cartridge carrier assemblies were examined with regard to those deficiencies found by the user. These included:

1. the formation of rust on the metal snaps and fasteners of the holster, cartridge carrier and associated straps.

2. the pulling loose of the snap retainer from the leather on the cartirdge carrier.

3. the flap corners on the cartridge carrier would roll up during tunnel or brush penetration permitting the cartridges to fall out.

4. the cartridge carrier would inadvertently shift on its associated belt or strap.

A conference with the holster manufacturer resulted in the following mutually agreeable changes and improvements:

1. increase the leather thickness of the cartridge carrier from 5 - 6 ounces per square foot to 7 - 8 ounces per square foot.

2. mold the cartridge carrier to more closely house the ammunition pack.

3. curve and taper the outside flaps of the cartridge carrier to eliminate projecting corners.

4. reduce size of belt slits on cartridge carrier and increase number of slits from two to four to permit double weaving of the belt.

5. interchange locations of spring fastener and "D" ring on holster and belt.

6. use improved quality military specification hardware that is black oxide coated for corrosion resistance.

Four new holster and cartridge carrier assemblies were fabricated accordingly and subsequently delivered as an end item.

(U) Contract Modification No. P00008 included a requirement for fabrication of two additional holster and cartridge carrier assemblies to the above improved configuration and they were subsequently delivered to the Government.

(C) E. Lethality Investigation

(C) An investigation was conducted to determine the optimum number of projectiles which would fit in the existing round, for maximum effectiveness at 30 foot range. Computer analyses were conducted for both partial and 100 percent incapacitation at 30 second defense, entire body-nude and a 20 mil aim error. In addition, P_K values for standard caliber .38 and .45 ammunition were computed to compare the results with existing sidearms.

(C) The results of the analyses are shown in Tables 1 and 2. It was concluded from these results that the existing projectile configuration; i.e., 15 - 7.5 grain Mallory spheres is the optimum configuration since the P_K is high for both partial and 100% incapacitation criteria.

(U) F. Test Data

(U) 1. Development Tests

(U) The numerous development test firings conducted throughout this program are not documented herein. However, two special tests made during the development phase are worthy of mention. The first was the measurement and recording of the peak sound pressure level (SPL) for three test firings. The revolver was hand held and sound recordings were obtained at a

PROJECTILE	VELOCITY (FPS)	BALLISTIC DISPERSION (MILS)	P_K AT 30'
1. Std .45 Caliber Ball	850	1	586
2. Std .38 Caliber	855	1	.534
3. 15 - 7.5 Grain Mallory Spheres	730	20	.803
4. 15 - 7.5 Grain Mallory Spheres	730	10	.891
5. 5 - 21 Grain Mallory Spheres	730	20	.663
6. 5 - 21 Grain Mallory Spheres	730	10	.753
7. 24 - 4.7 Grain Mallory Spheres	730	20	.902
8. 24 - 4.7 Grain Mallory Spheres	730	10	.958
9. 49 - 2.4 Grain Mallory Spheres	730	20	.933
10. 49 - 2.4 Grain Mallory Spheres	730	10	.977

(C) TABLE 1

LETHALITY DATA

30 SECOND DEFENSE, ENTIRE BODY - NUDE,

PARTIAL INCAPACITATION, 20 MIL AIM ERROR (U)

PROJECTILE	VELOCITY (FPS)	BALLISTIC DISPERSION (MILS)	P_K AT 30'
1. Std .45 Caliber Ball	850	1	.229
2. Std .38 Caliber	855	1	.189
3. 15 - 7.5 Grain Mallory Spheres	730	20	.208
4. 15 - 7.5 Grain Mallory Spheres	730	10	.245
5. 5 - 21 Grain Mallory Spheres	730	20	.175
6. 5 - 21 Grain Mallory Spheres	730	10	.208
7. 24 - 4.7 Grain Mallory Spheres	730	20	.157
8. 24 - 4.7 Grain Mallory Spheres	730	10	.187
9. 49 - 2.4 Grain Mallory Spheres	730	20	.000
10. 49 - 2.4 Grain Mallory Spheres	730	10	.000

(C) TABLE 2

LETHALITY DATA

30 SECOND DEFENSE, ENTIRE BODY - NUDE,

100% INCAPACITATION, 20 MIL AIM ERROR (U)

5 meter distance directly to the side of the muzzle. The following equipment was employed to obtain this data:

Microphone -------------	B&K Type 4133
Cathode Follower -------	B&K Type 2615
Microphone Power Supply-	B&K Type 2801
Oscilloscope -----------	Tektronix Type 543 with Tektronix Type 1A7A Plug In
Oscilloscope Camera ----	Tektronix Type C-27

The three peak to peak sound pressure levels recorded were 109.2, 111.5 and 112.0 decibels, respectively.

(U) The other special test firings were the five "proof" tests conducted during the development stage. These proof rounds were tested for functioning at 110% of the peak operating pressure of the regular round. Written certification of satisfactory completion of "proof" testing is included in this report in Appendix A.

(U) Contract Modification P00008 required modification of previously delivered ammunition. Three special test firings were made for function evaluation at 110% of the peak operating pressure of the regular round. Documentation of these tests is included in Appendix "D" of this report.

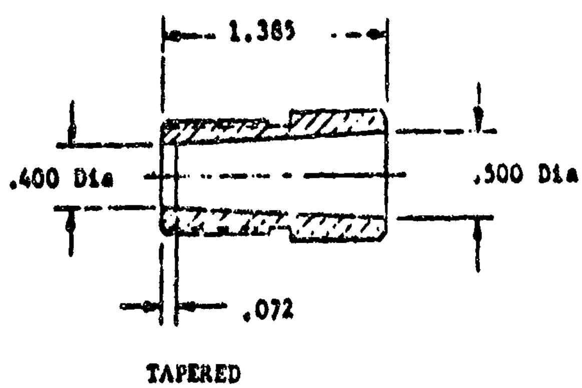
(U) 2. Assurance Tests

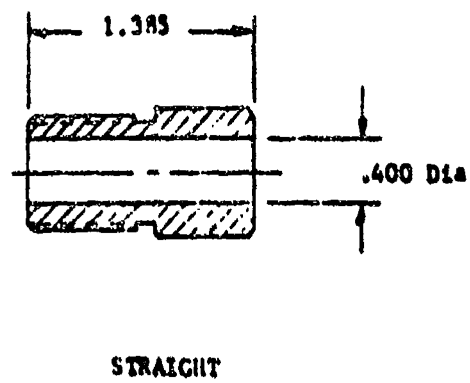
(U) The assurance tests for 200 improved QSPR rounds were conducted in the presence of the Government's Project Officer. These rounds reflected all of the latest design innovations and improved assembly techniques previously discussed in this report. Twenty-four rounds, preconditioned at +160°F for 18 hours were subjected to a five-foot drop test prior to firing, (Both nose and base down oriented) and allowed to impact on a 1.25

inch thick steel plate without any adverse effects. Numerous velocities were recorded at both 10 and 30 foot ranges, utilizing cast Pharmagel A gelatine blocks. A standard six-layer winter uniform was placed in front of the gel on some firing, as well as .25 inch thick masonite to simulate bone or skull structure. A complete chronological tabulation of the 200 assurance test firings in included in Appendix B, as well as physical characteristics and performance criteria. The successful firing of these 200 rounds for final Government approval, without a single misfire, represented the culmination of Phase I of the subject program.

(U) 3. Final Acceptance Tests

(U) The final acceptance tests of 125 improved QSPR rounds were conducted in the presence of the Government's Project Officer. Four new weapons were employed exclusively without incident and velocities were recorded at a 10 foot range on a 2 foot base line for practically all rounds. Dispersion patterns were obtained for ten rounds each of two barrel bore configurations and at two ranges, 25 and 50 feet. The two barrel bore configurations are shown below.





The actual ballistic dispersion for each of the 40 rounds has been computed and tabulated in Appendix C, along with a chronological listing of the 125 final acceptance test firings. In addition, peak sound pressure levels (SPL) were recorded at a 2 foot distance to the side of the muzzle and are also included. Specific SPL readings were obtained for the first 40 rounds, at which time the scale was changed and a screening process was employed thereafter that verified the SPL reading to be less than 140 decibels. This noise level is the maximum permitted by contract requirements at a point 12.5 feet down range and 2 feet to the side of the line of fire.

(U) At the completion of these tests, it was concluded that the straight bore barrel configuration afforded the most effective ballistic dispersion, therefore all four new weapons were retro-fitted with a straight bore barrel. The successful firing of these 125 rounds, again without a single misfire, distributed over four new weapons, represented the completion of all test requirements associated with this program. The program was completed with the delivery of four improved Quiet, Special-Purpose Revolvers, 1000 rounds of improved QSPR ammunition and four improved QSPR holster and cartridge carrier assemblies.

II. (U) CONCLUSIONS AND RECOMMENDATIONS

(U) The weapon and ammunition deficiencies noted during the RVN evaluations, particularly those reported as ammunition misfires, were caused by the weapons marginal firing pin energy and the complex anvil-primer design of the ammunition. The resulting design improvements and simplifications associated with this program were demonstrated to have corrected the malfunctions thru extensive development, assurance, final acceptance and reliability tests. The weapon systems effectiveness has further been enhanced with improved ballistic dispersion, improved protective finishes and improved holster assemblies.

(U) A series of firing tests were conducted by LWL to evaluate the reliability and effectiveness of the QSPR and ammunition. Analyses of the data showed the reliability of the weapon and ammunition to be good at this stage in the development and that the QSPR offers considerable lethality improvement over both the caliber .38 revolver and the caliber .45 pistol inside the ranges of interest.

(U) The next logical step in the development of this system is a production engineering program with the major goal of reducing the production costs and increasing reliability thru mass production techniques. Since the QSPR is made from a standard hand gun, and also since the ammunition will be used in much larger quantities than the weapon, it is obvious that a reduction in the cost of the ammunition will realize the most substantial savings.

APPENDIX "A"

CERTIFICATION OF "PROOF" TESTING

CONTRACT NO. DAAD05-70-C-0270

(U) In accordance with Section 4.g. of Exhibit "A", Scope of Work to the subject contract, AAI Corporation hereby certifies that the "proof" testing defined therein has been successfully completed.

(U) This "proof" test required that a minimum of five (5) Quiet, Special-Purpose Revolver Rounds be loaded and fired in the Quiet, Special-Purpose Revolver such that peak operating pressures equal to 110% of the normal operating pressure be generated. To conduct these tests, five rounds were loaded with 110% of the normal propellant charge which is 3.2 grains of M9 propellant. This overcharge is the maximum charge which can be loaded into the round.

(U) All five rounds functioned satisfactorily and produced an average velocity of 740 feet per second. The theoretical peak pressure generated for these overcharge rounds is 57,920 psi as compared to the normal operating peak pressure of 53,070 psi. The test results are on file at AAI.

APPENDIX "B"

TEST RESULTS OF 200 ASSURANCE TEST FIRINGS OF THE IMPROVED OSPR AMMUNITION

(C) The assurance tests consisted of 200 rounds that reflected all design innovations and improvements discussed in this report. All test firings were conducted with the weapon being hand held, and a full cylinder was employed at all times. The single and double action modes of weapon operation, as well as slow and rapid fire were interchanged throughout the test program. The following observations resulted from these tests.

a. RTV-118 sealed round - the average velocity out of seven readings at a 10 foot range was 701.71 feet per second.

b. RTV-112 sealed round - the average velocity out of nine readings at a 10 foot range was 706.67 feet per second.

c. RTV-118 sealed round - the average velocity out of four readings at a 50 foot range was 616.75 feet per second.

d. RTV-112 sealed round - the average velocity out of three readings at a 50 foot range was 611.33 feet per second.

e. RTV-118 sealed round - the average penetration out of 10 hits into bare gelatin at a 30 foot range was 4.85 inches.

f. RTV-118 sealed round - the average penetration out of 9 hits through a six layer winter uniform into gelatin at a 30 foot range was 3.22 inches.

g. RTV-118 sealed round - the average penetration out of 6 hits through .25 inch thick masonite into gelatin at a 30 foot range was 2.67 inches.

h. RTV-118 sealed round - the penetration from a single hit into bare gelatin at a 50 foot range was 4.50 inches.

i. RTV-112 sealed round - the average penetration out of 4 hits into bare gelatin at a 50 foot range was 4.69 inches.

j. RTV-118 sealed round - the average penetration out of 3 hits through a 6 layer winter uniform into gelatin at a 50 foot range was 2.42 inches.

k. RTV-112 sealed round - the penetration from a single hit through a 6 layer winter uniform into gelatin at a 50 foot range was 2.25 inches.

l. RTV-118 sealed round - the average penetration out of 5 hits through .25 inch thick masonite into gelatin at a 50 foot range was 2.05 inches.

m. there was no significant difference in performance between the two types of adhesive-sealants employed.

(U) A few problems were encountered with the ammunition during the test firings. Of the 200 rounds, 161 were fired from the primary weapon and the remaining 39 rounds were fired from the secondary weapon. (Weapon differences and problem areas are fully discussed later). Only one round fired from the primary weapon (Round No. 127) was cataloged as a possible primer puncture. Magnifying glass examination of this round after the fact indicated that it was erroneously cataloged. Another questionable primer puncture (Round No. 153) and three definite primer punctures (Rounds No.s 137, 139 and 164) occurred while using the secondary weapon. These latter primer punctures have all been correlated to defective inserts in the breech face of the weapon. In addition, the primer on Round No. 98 actually extruded up into the firing pin hole around the firing pin but did not puncture, and in so doing, prevented the cylinder from rotating. This is the first and only time that the primer has extruded in this manner throughout the entire program and can only be attributed to an exceptionally soft primer cup. Hardness readings for verification were not possible because of the primer's captivated configuration.

Lastly, the cartridge case expanded several thousandths of an inch on four rounds in the area of the piston at the stopping threads. This occurred on Rounds Nos. 82, 133, 136 and 179 and made round extraction difficult in various degrees. No explanation can be offered for this phenomena since subsequent examination revealed that the rounds possessed the correct hardness, heat treat, initial size, etc.

(U) As previously mentioned, two used CFP weapons were utilized during this assurance test. It was originally planned to conduct most of the firings on a single weapon, but to have a back-up weapon in the event of a weapon failure; thus, the terminology of primary and secondary weapons. The primary weapon contained a .562 inch diameter hardened insert in the breech face, the dual spring installation, and a modified Smith & Wesson firing pin. The secondary weapon contained a similar dual spring installation, and a modified Smith & Wesson firing pin. At the onset of the tests, however, this latter weapon did not contain the .562 inch diameter hardened insert that existed in the primary weapon.

(U) The primary weapon was utilized initially for the first 50 rounds when the pin on the cylinder hand broke preventing cylinder indexing. The secondary weapon was then employed for 10 rounds and two primer punctures occurred (Rounds No. 137 and 139). By this time the cylinder hand had been replaced and testing was resumed with the primary weapon. After 45 more rounds the hammer pivot pin sheared rendering the weapon inoperative. Nine additional rounds were then fired from the secondary weapon in order to complete the penetration testing and a questionable primer puncture occurred (Round No. 153).

(U) With regard to the hammer pivot pin and hand pin failure on the primary weapon, it was concluded that the severe hammer rebound environment that this GFP weapon had experienced with the unimproved ammunition, may have had a deteriorating effect on these relatively soft pins. Other pivot pins in the weapon had previously been replaced with higher strength material equivalents on earlier programs, but such was not the case with the two aforementioned failures. Both pins on the primary weapon were successfully replaced with heat treated equivalents and testing was completed without further incident.

(U) In assessing the primer punctures that had occurred up to this point, it became interesting to note a very significant difference in the frequency of occurrence between the two weapons. The primary weapon had been fired 95 times with one erroneously labeled primer puncture, while the secondary weapon had yielded two definite and one questionable primer punctures in only 19 firings. Upon examination of these punctures from the secondary weapon, it became evident that the mashed primer crimped surface was not flat and perpendicular to the longitudinal axis of the round. Inspection of the breech face of the secondary weapon revealed that the small (.250 inch diameter) Smith and Wesson insert around the firing pin was recessed below the breech face and was actually cocked or canted and not parallel to the breech face. It was therefore concluded that a bearing failure was occurring in the weapon frame supporting this small insert, and that there was no bearing failure in the primary weapon because of the much larger (.562 inch diameter) insert possessing 5 times more bearing area. It was further concluded that this

defect existing or the secondary weapon was responsible for the high incidence of primer punctures, this being the one and only difference between weapons. As a result of these conclusions, a large .562 inch diameter hardened insert was installed in the secondary weapon, similar to the one existing in the primary weapon.

(U) Test firings were resumed and six rounds were fired initially from the primary weapon to check out the heat treated hammer pin installation. The secondary weapon was then employed to check out the hardened insert installation and 20 rounds were fired before any problems developed. A primer puncture occurred on Round No. 164 but was attributed to a failure in the insert recently installed in the secondary weapon. The insert was found to have contained a flaw in that the 30° vertical slot was cut too deep and broke out into the firing pin hole. As a result, a cave-in occurred in the vicinity of this weakened section which affected the restraint afforded to the primer. The primer on Round No. 165 extruded up into the insert failure the same as Round No. 164 but did not puncture. The remaining 60 rounds were fired from the primary weapon without any further primer problems except for Round No. 98 previously discussed. This completed the design assurance test and evaluation of 200 improved Quiet, Special-Purpose Rounds.

(U) CHRONOLOGICAL TABULATION OF PPG ASSURANCE TEST FIRINGS OF THE IMPROVED QSPR AMMUNITION

Test Firing Sequence	Date Fired	Round No.	Type RTV at Sabot End	Round O.A.L. 1.866 1.856 (in.)	Case O.A.L. 1.853 1.850 (in.)	Crimp Projection Above Case .016 .015 (in.)	Head Space .003 .009 (in.)	Weapon	Weapon Operation	Range at Event (feet)	Objective/Performance	Results/Remarks
1	8/14	13	118	1.866	1.857	.009	.005	P	S/A	10	Velocity	Primer O.K.
2		14		1.867	1.857	.010	.004				Velocity	
3		15		1.867	1.856	.011	.006				Velocity = 688 fps	
4		16		1.865	1.857	.008	.006				Velocity	
5		17		1.863	1.856	.011	.004				Velocity = 768 fps	
6		18		1.863	1.856	.009	.006		S/A		Velocity = 672 fps	
7		19		1.868	1.857	.012	.003		D/A		Velocity = 672 fps	
8		20		1.865	1.857	.008	.006				Velocity = 723 fps	
9		21		1.868	1.856	.012	.003				Velocity = 666 fps	
10		22		1.866	1.857	.009	.005				Velocity = 726 fps	
11		23		1.866	1.856	.010	.005				Velocity	
12		24	118	1.866	1.856	.010	.005		S/A		Velocity	
13		113	117	1.866	1.856	.010	.005		S/A		Velocity	
14		114		1.867	1.856	.011	.004				Velocity	
15		115		1.867	1.855	.012	.006				Velocity = 696 fps	
16		116		1.866	1.857	.009	.005				Velocity = 732 fps	
17		117		1.868	1.856	.012	.003				Velocity = 730 fps	
18		118		1.866	1.855	.011	.005		S/A		Velocity = 618 fps	
19		119		1.866	1.855	.011	.005		D/A		Velocity = 736 fps	
20		120		1.867	1.857	.010	.004				Velocity = 752 fps	
21		121		1.861	1.854	.011	.004				Velocity = 732 fps	
22		122		1.867	1.855	.012	.004				Velocity = 695 fps	
23	8/14	123	112	1.867	1.855	.012	.004	P	D/A	10	Velocity = 706 fps	Primer O.K.

(U) CHRONOLOGICAL TABULATION OF PRODUCT ASSURANCE TEST FIRINGS OF THE IMPROVED QSPR AMMUNITION (CONTINUED)

Test Firing Sequence	Date Fired	Round No.	Type STV at Sched. End	Round O.A.L. 1.866 / 1.868 (in.)	Case O.A.L. 1.853 / 1.858 (in.)	Crimp Projection Above Case .005 / .015 (in.)	Head Space .001 / .009 (in.)	* Weapon	** Weapon Operation	Range at Event (feet)	Objective/Performance	Results/Remarks
24	8/16	124	112	1.866	1.856	.010	.005	P	B/A	10	Velocity	Primer O.K.
25		25	110	1.866	1.853	.011	.005		S/A	50	Velocity	
26		26		1.866	1.853	.011	.005				Velocity	
27		27		1.867	1.856	.011	.006				Velocity = 686 fps	
28		28		1.867	1.853	.010	.006				Velocity	
29		29		1.865	1.856	.009	.006				Velocity	
30		30		1.867	1.856	.011	.006		S/A		Velocity	
31		31		1.866	1.855	.011	.005		B/A		Velocity = 686 fps	
32		32		1.866	1.856	.010	.005				Velocity	
33		33		1.866	1.856	.010	.005				Velocity = 632 fps	
34		34		1.866	1.858	.010	.005				Velocity	
35		35		1.865	1.857	.008	.006				Velocity	
36		36	118	1.865	1.856	.010	.005		B/A		Velocity	
37		125	112	1.866	1.857	.009	.005		S/A		Velocity	
38		126		1.866	1.857	.009	.005				Velocity	Primer O.K.
39		127		1.867	1.855	.012	.006				Velocity = 570 fps	Possible primer puncture - Erroneously labeled
40		128		1.867	1.859	.012	.006				Velocity	Primer O.K.
41		129		1.865	1.855	.010	.006				Velocity	
42		130		1.867	1.856	.011	.006		S/A		Velocity	
43		131		1.867	1.855	.012	.006		B/A		Velocity	
44		132		1.867	1.856	.012	.006				Velocity	
45	8/16	133	112	1.867	1.859	.012	.006	P	B/A	50	Velocity	Primer O.K.

(U) CHRONOLOGICAL TABULATION OF 200 ACCEPTANCE TEST FIRINGS OF THE IMPROVED QSPR AMMUNITION (CONTINUED)

Test Firing Sequence	Date Fired	Round No.	Type XM at Select Lot	Round O.A.L. 1.864 1.868 (in.)	Case O.A.L. 1.853 1.858 (in.)	Crimp Projection Above Case .005 .015 (in.)	Head Space .003 .009 (in.)	* Weapon	** Weapon Operation	Range at Event (feet)	Objective/Performance	Results/Remarks
46	8/16	134	112	1.867	1.853	.012	.006	F	B/A	50	Velocity	Primer O.K.
47		135		1.867	1.855	.012	.004				Velocity = 636 fps	
48		136	112	1.867	1.856	.011	.004		B/A		Velocity	
49		37	115	1.866	1.855	.011	.005		S/A		Velocity	
50		38		1.867	1.855	.012	.004	F			Velocity	
51		39		1.866	1.856	.010	.00[illegible]	S	S/A		Velocity	
52		40		1.866	1.857	.009	.005		B/A		Velocity	
53		41		1.865	1.856	.009	.006				Velocity	
54		42	118	1.867	1.856	.011	.006		B/A		Velocity = 623 fps	Primer O.K.
55		137	112	1.867	1.856	.011	.006		S/A		Velocity = 628 fps	Primer Punctured
56		138		1.866	1.857	.011	.003				Velocity	Primer O.K.
57		139		1.866	1.856	.010	.005		S/A		Velocity	Primer Punctured
58		140		1.867	1.856	.011	.006		B/A		Velocity	Primer O.K.
59		141		1.868	1.856	.012	.003				Velocity	
60		142	112	1.867	1.857	.010	.006	S	B/A	50	Velocity	
61		1	118	1.868	1.857	.011	.003	F	S/A		5 Ft. Drop Test at +160°F (Base Down)	
62		2		1.866	1.856	.010	.005					
63		3		1.868	1.856	.012	.003		S/A			
64		4		1.866	1.856	.010	.005		B/A			
65		5		1.866	1.856	.010	.005					
66		6		1.866	1.857	.009	.005		B/A		(Base Down)	
67		7		1.868	1.856	.012	.003		S/A		(Base Down)	
68	8/16	8	118	1.867	1.857	.010	.004	F	S/A		5 Ft. Drop Test at +160°F (Base Down)	Primer O.K.

(C) CHRONOLOGICAL TABULATION OF 200 ASSURANCE TEST FIRINGS OF THE IMPROVED QSPR AMMUNITION (CONTINUED) (U)

Test Firing Sequence	Date Fired	Round No.	Type KTV at Subass'y End	Round O.A.L. 1.844 / 1.868 (in.)	Case O.A.L. 1.851 / 1.858 (in.)	Crimp Projection Above Case .005 / .015 (in.)	Head Space .003 / .009 (in.)	Weapon	On Weapon Operation	Range at Event (feet)	Objective/Performance	Results/Remarks
69	8/14	9	119	1.866	1.856	.010	.005	F	S/A		5 Ft. Drop Test at +160°F (Nose Down)	Primer O.K.
70		10		1.865	1.857	.008	.006		D/A			
71		11		1.865	1.855	.010	.006					
72		12	116	1.867	1.857	.010	.004		D/A		(Nose Down)	
73		101	117	1.867	1.855	.012	.004		S/A		(Base Down)	
74		102		1.857	1.854	.012	.006					
75		103		1.866	1.856	.010	.005		S/A			
76		104		1.867	1.855	.012	.006		D/A			
77		105		1.866	1.855	.011	.005					
78		106		1.867	[illegible]	.010	.006		D/A		(Base Down)	
79		107		1.866	1.856	.010	.005		S/A		(Nose Down)	
80		108		1.867	1.856	.011	.006					
81		109		1.865	1.855	.010	.005		S/A			
82		110		1.866	1.854	.012	.005		D/A			
83		111		1.866	1.850	.010	.005					
84		112	112	1.867	1.856	.011	.006		D/A		5 Ft. Drop Test at +160°F (Nose Down)	
85		43	118	1.866	1.857	.009	.005		S/A	30	Bare Gel Penetration, 1 hit at 5.0"	
86		44		1.866	1.855	.011	.005				Bare Gel Penetration, 2 hits at 4.5", 2 hits at 5.0", 1 hit at 5.5"	
87		45		1.866	1.857	.009	.005				Bare Gel Penetration, 2 hits at 4.5", 2 hits at 5.0"	
88		46		1.866	1.856	.010	.005				6 Layer Uniform over Gel Penetration, No hits	
89	8/24	47	116	1.865	1.856	.009	.006	F	S/A	30	6 Layer Uniform over Gel Penetration, No hits	Primer O.K.

(C) CHRONOLOGICAL TABULATION OF 200 ACCEPTABLE TEST FIRINGS OF THE IMPROVED QGSR AMMUNITION (CONTINUED) (U)

Test Firing Sequence	Date Fired	Round No.	Type RTV at Schot Lot	Round G.A.L. 1.866 1.848 (in.)	Case G.A.L. 1.853 1.854 (in.)	Crimp Projection Above Case .020 .015 (in.)	Head Space .001 .009	* Weapon	** Weapon Operation	Range at Event (feet)	Objective/Performance	Results/Remarks
90	8/14	48	114	1.866	1.856	.018	.005	P	S/A	30	6 Layer Uniform over Gel Penetration, 1 hit at 2.0", 2 hits at 3.0"	Primer O.K.
91		49		1.865	1.855	.016	.006				6 Layer Uniform over Gel Penetration, No hits	
92		50		1.867	1.856	.012	.006				6 Layer Uniform over Gel Penetration, 1 hit at 3.0", 4 hits at 3.5", 1 hit at 4.0"	
93		51		1.865	1.857	.008	.006				¼" Masonite over Gel Penetration, 1 hit at 2.0", 1 hit at 2.5", 1 hit at 3.0"	
94		52		1.866	1.856	.01-	.005			30	¼" Masonite over Gel Penetration, 1 hit at 2.5", 2 hits at 3.0"	
95		53		1.866	1.857	.009	.005			50	Bare Gel Penetration, 1 hit at 4.5"	
96		54	118	1.867	1.857	.010	.004				, No hits	
97		143	112	1.867	1.855	.012	.006				, 1 hit at 4.75"	
98		144		1.867	1.856	.018	.004				, No hits	
99		145		1.867	1.856	.011	.004					
100		146		1.865	1.857	.008	.006					
101		147		1.867	1.855	.012	.004				, No hits	
102		148		1.866	1.855	.011	.005				Bare Gel Penetration, 1 hit at 4.25", 1 hit at 4.75"	
103		149		1.867	1.853	.012	.004				Bare Gel Penetration, No hits	
104		150		1.867	1.856	.011	.004				, No hits	
105		151		1.865	1.856	.009	.006	P			Bare Gel Penetration, 1 hit at 5.0"	
106		152		1.865	1.856	.009	.006	S			6 Layer Uniform over Gel Penetration 1 hit at 2.25"	Primer O.K.
107	8/14	153	112	1.867	1.857	.010	.004	S	S/A	50	6 Layer Uniform over Gel Penetration, No hits	Questionable Primer Puncture

(C) CHRONOLOGICAL TABULATION OF 200 ASSURANCE TEST FIRINGS OF THE IMPROVED 9MM AMMUNITION (CONTINUED) (U)

Test Firing Sequence	Date Fired	Round No.	Type BTT at Sub-t End	Round O.A.L. 1.846 / 1.868 (in.)	Case O.A.L. 1.853 / 1.858 (in.)	Crimp Projection Above Case .004 / .015 (in.)	Head Space .003 / .009 (in.)	* Weapon	** Weapon Operation	Range of Event (feet)	Objective/Performance	Results/Remarks
108	8/2-	154	112	1.866	1.857	.009	.005	S	S/A	50	6 Layer Uniform over Gel Penetration, No hits	Primer O.K.
109		55	118	1.867	1.855	.012	.004				6 Layer Uniform over Gel Penetration, No hits	
110		56		1.866	1.856	.010	.005				6 Layer Uniform over Gel Penetration, 1 hit at 2.5"	
111		57		1.865	1.857	.008	.006				6 Layer Uniform over Gel Penetration, No hits	
112		58		1.866	1.855	.012	.005				6 Layer Uniform over Gel Penetration, 1 hit at 2.25", 1 hit at 2.5"	
113		59		1.865	1.855	.010	.006				½" Masonite over Gel Penetration, 1 hit at 1.50", 2 hits at 1.75", 1 hit at 2.75"	
114	8/24	60		1.867	1.856	.011	.006	S			½" Masonite over Gel Penetration, 1 hit at 2.50"	
115	8/21	61		1.866	1.856	.010	.005	P			Dispersion Pattern	
116		62		1.865	1.857	.008	.006					
117		63	118	1.866	1.856	.012	.003					Primer O.K.
118		155	112	1.866	1.856	.010	.005					Primer O.K. Round Expanded Difficult to Extract
119		156		1.866	1.855	.011	.005					Primer O.K. Round Expanded Difficult to Extract
120		157	112	1.867	1.857	.010	.006	P	S/A	50	Dispersion Pattern	Primer O.K.
121		64	118	1.866	1.856	.010	.005	S	B/A		Slow Fire	
122		65		1.866	1.857	.009	.005					
123		66		1.867	1.856	.011	.004					
124		67		1.866	1.857	.009	.005					
125	8/21	68	118	1.866	1.857	.009	.005	S	B/A		Slow Fire	Primer O.K.

(U) CHRONOLOGICAL TABULATION OF [illegible] ASSURANCE TEST FIRINGS OF THE IMPROVED [illegible] AMMUNITION (CONTINUED)

Test Firing Sequence	Date Fired	Round Nr.	Type PTC or Sabot Lm.	Round O.A.L. 1.866 1.868 (in.)	Case O.A.L. 1.853 1.850 (in.)	Crimp Projection Above Case .006 .015 (in.)	Head Space .003 .009 (in.)	Weapon	Weapon Operation	Range at Event (feet)	Objective/Performance	Results/Remarks
126	8/71	69	11[illegible]	1.866	1.857	.009	.005	S	D/A		Slow Fire	Primer O.K.
127		70		1.867	1.855	.012	.006				Rapid Fire	
128		71		1.867	1.857	.010	.006					
129		72		1.865	1.856	.009	.006					
130		73		1.868	1.855	.013	.003					
131		74		1.867	1.856	.012	.006					
132		75	116	1.867	1.855	.012	.006				Rapid Fire	
133		158	112	1.866	1.856	.016	.005				Slow Fire	
134		159		1.866	1.857	.008	.005					
135		160		1.866	1.857	.009	.005					
136		161		1.867	1.858	.011	.006					
137		162		1.867	1.855	.012	.006					
138		163		1.867	1.856	.011	.004				Slow Fire	Primer O.K.
139		164		1.868	1.855	.013	.003				Rapid Fire	Primer Puncture due to Insert Failure
140		165		1.866	1.855	.021	.005	S				Primer flow thru insert but no puncture
141		166		1.866	1.856	.018	.005	P				Primer O.K.
142		167		1.867	1.856	.011	.006					
143		168		1.867	1.856	.011	.006					
144		169		1.866	1.856	.010	.005					
145		170		1.867	1.857	.010	.006					
146		171	112	1.867	1.856	.011	.004				Rapid Fire	
147	8/71	76	116	1.866	1.856	.012	.005	P	D/A		Slow Fire	Primer O.K.

(U) CHRONOLOGICAL TABULATION OF 300 ASSURANCE TEST FIRINGS OF THE "IMPROVED [illegible]

Test Firing [illegible]	Date [illegible]	Round No.	Type BTV at Sabot End	Round O.A.L. 1.8[illegible] 1.868 (in.)	Case O.A.L. 1.851 1.856 (in.)	Crimp Projection Above Case .006 .015 (in.)	Head Space .023 .069 (in.)	* Weapon	** Weapon Operation	Range at Event (feet)	Objective/Performance	Results/Remarks
1[illegible]	[illegible]	77	118	1.867	1.857	.01[illegible]	.004	P	B/A		Slow Fire	Primer O.K.
149		78		1.868	1.855	.011	.005					
150		79		1.866	1.855	.011	.005					
151		80		1.867	1.857	.010	.004					
152		81		1.867	1.857	.010	.004				Slow Fire	Primer O.K.
153		82		1.867	1.856	.013	.004				Rapid Fire	Primer O.K. Round Expanded Difficult to Extract
154		83		1.867	1.857	.010	.004					Primer O.K.
155		84		1.867	1.855	.012	.004					
156		85		1.867	1.857	.010	.004					
157		86		1.867	1.857	.010	.004					
158		87		1.867	1.855	.012	.006				Rapid Fire	
159		88		1.867	1.857	.010	.004				Slow Fire	
160		89		1.866	1.856	.010	.005					
161		90		1.866	1.856	.010	.005					
162		91		1.866	1.857	.009	.005					
163		92		1.865	1.856	.012	.003					
164		93		1.864	1.856	.008	.007				Slow Fire	
165		94		1.866	1.856	.010	.005				Rapid Fire	
166		95		1.867	1.855	.012	.004					
167		96		1.867	1.856	.011	.004					
168		97		1.866	1.857	.009	.005					Primer O.K.
169	[illegible]/71	98	118	1.867	1.856	.011	.004	P	B/A		Rapid Fire	Primer Extruded thru Firing Pin Hole. No puncture

(U) CHRONOLOGICAL TABULATION OF 200 ASSURANCE TEST FIRINGS OF THE IMPROVED QSTR AMMUNITION (CONTINUED)

Test Firing Sequence	Date Fired	Round No.	Type BTV at Subst End	Round O.A.L. 1.864 1.868 (in.)	Case O.A.L. 1.853 1.858 (in.)	Crimp Projection Above Case .006 .013 (in.)	Head Space .003 .009 (in.)	Weapon	Weapon Operation	Range at Event (feet)	Objective/Performance	Results/Remarks
170	8/21	99	118	1.860	1.857	.009	.005	P	B/A		Rapid Fire	Primer O.K.
171		169	118	1.867	1.855	.012	.004				Slow Fire	
172		172	112	1.867	1.855	.012	.004					
173		173		1.867	1.856	.012	.006					
174		174		1.865	1.856	.009	.006					
175		175		1.866	1.855	.011	.005					
176		176		1.865	1.856	.009	.006				Slow Fire	
177		177		1.867	1.856	.011	.004				Rapid Fire	
178		178		1.866	1.855	.011	.005					Primer O.K.
179		179		1.866	1.856	.010	.005					Primer O.K. Round Expanded Difficult to Extract
180		180		1.867	1.855	.011	.004					Primer O.K.
181		181		1.866	1.857	.009	.005					
182		182		1.867	1.856	.011	.004				Rapid Fire	
183		183		1.866	1.857	.009	.005				Slow Fire	
184		184		1.866	1.856	.010	.005					
185		185		1.867	1.856	.011	.004					
186		186		1.867	1.855	.012	.004					
187		187		1.867	1.857	.010	.004					
188		188		1.866	1.856	.010	.005				Slow Fire	
189		189		1.866	1.856	.010	.005				Rapid Fire	
190		190		1.866	1.856	.010	.005					
191	8/21	191	112	1.867	1.856	.011	.004	P	B/A		Rapid Fire	Primer O.K.

(U) CHRONOLOGICAL TABULATION OF [illegible] ASSURANCE TEST FIRINGS OF THE IMPROVED QSPR AMMUNITION (CONTINUED)

Test Firing Sequence	Date Fired	Round No.	Type LTC at Subst In	Round O.A.L. 1.846 1.866 (in.)	Case O.A.L. 1.853 1.858 (in.)	Crimp Projection Above Case .009 .015 (in.)	Head Space .003 .009 (in.)	* Weapon	** Weapon Operation	Range at Event (feet)	Objective/Performance	Results/Remarks
192	[illegible]	192	112	1.867	1.857	.010	.004	P	D/A		Rapid Fire	Primer O.K.
193		193		1.867	1.856	.011	.004					
194		194		1.866	1.856	.010	.005				Rapid Fire	
195		195		1.867	1.856	.011	.004				Slow Fire	
196		196		1.860	1.856	.018	.005					
197		197		1.866	1.856	.010	.005					
198		198		1.866	1.856	.010	.005					
199		199	112	1.866	1.857	.009	.005					
200	8/21	E-72	118	1.867	1.848	.019	.004	P	D/A		Slow Fire	Primer O.K.

* P = Primary Weapon
S = Secondary Weapon

** S/A = Single Action
D/A = Double Action

APPENDIX "C"

TEST RESULTS OF 125 FINAL DESIGN ACCEPTANCE TEST FIRINGS OF THE IMPROVED QUIET, SPECIAL-PURPOSE REVOLVER AND AMMUNITION

(C) The final acceptance tests consisted of 125 improved rounds and were distributed over four new improved weapons. All test firings were conducted with the weapon being hand held, and a full cylinder was employed at all times. Again, both single and double action modes of weapon operation were utilized as well as slow and rapid fire. The following observations resulted from these tests:

a. the average velocity of 86 rounds at a 10 foot range was 703.3 feet per second.

b. the average ballistic dispersion of ten rounds with the tapered barrel at a 25 foot range was 9.02 mils.

c. the average ballistic dispersion of ten rounds with the tapered barrel at a 50 foot range was 9.93 mils.

d. the average ballistic dispersion of ten rounds with the straight barrel at a 25 foot range was 6.67 mils.

e. the average ballistic dispersion of ten rounds with the straight barrel at a 50 foot range was 6.93 mils.

(C) CHRONOLOGICAL TABULATION OF 125 FINAL DESIGN ACCEPTANCE TEST FIRINGS OF THE IMPROVED QUIET, SPECIAL-PURPOSE REVOLVER AND AMMUNITION (U)

Round No.	Date Fired	* Weapon No.	** Weapon Operation	Velocity at 10 Ft. (fps)	Δ SPL (decibels)	Barrel Configuration	ΔΔ Ballistic Dispersion (mils)	Results/Remarks
1	12/15/70	1	S/A	688	-	Tapered	6.98	Primer/Weapon OK
2				692	123.5		7.73	
3				686	119.6		9.44	
4				760	120.9		12.67	
5				702	119.6		13.17	
6				694	119.6		9.29	
7				636	122.2		10.06	
8				-	119.6		5.06	
9				-	120.9		11.02	
10				694	123.5	Tapered	4.81	
11				662	117.0	Straight	8.18	
12				688	120.9		6.21	
13				674	119.6		6.59	
14				684	122.2		7.06	
15				680	119.6		6.76	
16	12/15/70	1	S/A	712	120.9	Straight	7.29	Primer/Weapon OK

(C) CHRONOLOGICAL TABULATION OF 125 FINAL DESIGN ACCEPTANCE TEST FIRINGS OF THE IMPROVED QUIET, SPECIAL-PURPOSE REVOLVER AND AMMUNITION (CONT'D) (U)

Round No.	Date Fired	* Weapon No.	** Weapon Operation	Velocity at 10 Ft. (fps)	Δ SPL (decibels)	Barrel Configuration	ΔΔ Ballistic Dispersion (mils)	Results/Remarks
17	12/15/70	1	S/A	712	119.6	Straight	7.89	Primer/Weapon OK
18				714	122.2		7.23	
19				694	120.9		4.61	
20				692	120.9		5.08	
21				726	123.5		5.66	
22				700	119.6		8.16	
23				706	118.3		6.12	
24				708	118.3		6.27	
25				-	118.3		5.49	
26				718	119.6		5.49	
27				708	120.9		8.21	
28				698	117.0		9.21	
29				700	118.3		6.04	
30				680	119.6	Straight	8.64	
31	12/15/70	1	S/A	-	117.0	Tapered	6.46	Primer/Weapon OK

(C) CHRONOLOGICAL TABULATION OF 125 FINAL DESIGN ACCEPTANCE TEST FIRINGS OF THE IMPROVED QUIET, SPECIAL-PURPOSE REVOLVER AND AMMUNITION (CONT'D) (U)

Round No.	Date Fired	* Weapon No.	** Weapon Operation	Velocity at 10 Ft. (fps)	Δ SPL (decibels)	Barrel Configuration	ΔΔ Ballistic Dispersion (mils)	Results/Remarks
32	12/15/70	1	S/A	716	119.6	Tapered	11.87	Primer/Weapon OK
33				686	117.0		8.98	
34				-	118.3		14.19	
35				682	117.0		12.21	
36				700	119.6		8.71	
37				686	117.0		11.18	
38				698	119.6		6.38	Primer/Weapon OK
39				696	> 130.0		11.18	Pin Hole Primer Puncture, Weapon OK
40	12/15/70	1		696	119.6		8.13	Primer/Weapon OK
41	12/21/70	2		702	< 140.0		-	
42				686				
43				740				
44				718				
45				754				
46	12/21/70	2	S/A	714	< 140.0	Tapered	-	Primer/Weapon OK

(U) CHRONOLOGICAL TABULATION OF 125 FINAL DESIGN ACCEPTANCE TEST FIRINGS OF THE IMPROVED QUIET, SPECIAL-PURPOSE REVOLVER AND AMMUNITION (CONT'D)

Round No.	Date Fired	* Weapon No.	** Weapon Operation	Velocity at 10 Ft. (fps)	Δ SPL (decibels)	Barrel Configuration	ΔΔ Ballistic Dispersion (mils)	Results/Remarks
47	12/21/70	2	S/A	684	< 140.0	Tapered	-	Primer/Weapon OK
48				742				
49				692				
50				742				
51				724				
52				712				
53				-				
54				686				
55				694				
56				-				
57				714				
58			S/A	702				
59			D/A	-				
60								
61	12/21/70	2	D/A	-	< 140.0	Tapered	-	Primer/Weapon OK

(U) CHRONOLOGICAL TABULATION OF 125 FINAL DESIGN ACCEPTANCE TEST FIRINGS OF THE IMPROVED QUIET, SPECIAL-PURPOSE REVOLVER AND AMMUNITION (CONT'D)

Round No.	Date Fired	* Weapon No.	** Weapon Operation	Velocity at 10 Ft. (fps)	Δ SPL (decibels)	Barrel Configuration	ΔΔ Ballistic Dispersion (mils)	Results/Remarks
62	12/21/70	2	D/A	-	< 140.0	Tapered	-	Primer/Weapon OK
63								
64			D/A	-				
65		2	S/A	734				
66		3		682				
67				-				
68				724				
69				716				
70				716				
71				-				
72				688				
73				706				
74				568				
75				-				
76				678				
77	12/21/70	3	S/A	698	< 140.0	Tapered	-	Primer/Weapon OK

(U) CHRONOLOGICAL TABULATION OF 125 FINAL DESIGN ACCEPTANCE TEST FIRINGS OF THE IMPROVED QUIET, SPECIAL-PURPOSE REVOLVER AND AMMUNITION (CONT'D)

Round No.	Date Fired	* Weapon No.	** Weapon Operation	Velocity at 10 Ft. (fps)	Δ SPL (decibels)	Barrel Configuration	ΔΔ Ballistic Dispersion (mils)	Results/Remarks
78	12/21/70	3	S/A	708	< 140.0	Tapered	-	Primer/Weapon OK
79				694				
80				700				
81				-				
82				696				
83			S/A	-				
84			D/A					
85								
86								
87								
88								
89			D/A					
90			S/A					
91				-				
92				686				
93	12/21/70	3	S/A		< 140.0	Tapered	-	Primer/Weapon OK

(U) CHRONOLOGICAL TABULATION OF 125 FINAL DESIGN ACCEPTANCE TEST FIRINGS OF THE IMPROVED QUIET, SPECIAL-PURPOSE REVOLVER AND AMMUNITION (CONT'D)

Round No.	Date Fired	* Weapon No.	** Weapon Configuration	Velocity at 10 Ft. (fps)	Δ SPL (decibels)	Barrel Configuration	ΔΔ Ballistic Dispersion (mils)	Results/Remarks
94	12/21/70	3	S/A	-	< 140.0	Tapered	-	Primer/Weapon OK
95		3		706				
96		4		712				
97				718				
98				714				
99				732				
100				780				
101				698				
102				708				
103				698				
104				746				
105				694				
106				742				
107				700				
108				714				
109	12/21/70	4	S/A	694	< 140.0	Tapered	-	Primer/Weapon OK

(U) CHRONOLOGICAL TABULATION OF 125 FINAL DESIGN ACCEPTANCE TEST FIRINGS OF THE IMPROVED QUIET, SPECIAL-PURPOSE REVOLVER AND AMMUNITION (CONT'D)

Round No.	Date Fired	* Weapon No.	** Weapon Operation	Velocity at 10 Ft. (fps)	Δ SPL (decibels)	Barrel Configuration	ΔΔ Ballistic Dispersion (mils)	Results/Remarks
110	12/21/70	4	S/A	-	< 140.0	Tapered	-	Primer/Weapon OK
111								
112				-				
113			S/A	712				
114			D/A	-				
115								
116								
117								
118								
119			D/A	-				
120			S/A	686				
121				-				
122				-				
123				688				
124				692				
125	12/21/70	4	S/A	714	< 140.0	Tapered	-	Primer/Weapon OK

(U) CHRONOLOGICAL TABULATION OF 125 FINAL DESIGN ACCEPTANCE TEST FIRINGS OF THE IMPROVED QUIET, SPECIAL-PURPOSE REVOLVER AND AMMUNITION (CONT'D)

NOTES:

* Weapon No. 1 = S/N S 319285
Weapon No. 2 = S/N S 319359
Weapon No. 3 = S/N S 319425
Weapon No. 4 = S/N S 319925

** S/A = Single Action, Slow Fire
D/A = Double Action, Rapid Fire

Peak Sound Pressure Level Recorded 2 Feet to Side of Muzzle

Ballistic Dispersion
Rounds 1 thru 20 = 25 foot range
Rounds 21 thru 40 = 30 foot range

APPENDIX "D"

ACCEPTANCE TEST OF REWORKED QSPR AMMUNITION

The acceptance test firing of seventy-nine (79) reworked rounds of QSPR Ammunition was conducted on 2 April, 27 April, 29 April and 30 April 1971, respectively. The primary objective of these tests was to assure complete and proper functioning of the ammunition and weapons, and to ascertain the integrity of the aforementioned redesign. Particular emphasis was placed on ammunition chambering and feeding within the revolver itself, and the freedom with which the cylinder is permitted to rotate from both fired and unfired rounds. All six weapons were employed throughout the tests, a full cylinder was employed at all times, numerous velocities were obtained, and both the single and double action modes of weapon operation were used. A greater number of rounds were devoted to Weapon's No.'s 5 and 6, since these were completely new weapons and here-to-fore unfired.

The first three test firings were conducted on 2 April without incident, although these rounds were loaded with 110% of the normal propellant charge and represents a "proof" test with 110% of the peak operating pressure of the regular round. Further testing was resumed on 27 April in the presence of the Project Officer, and all forty-two (42) rounds and six (6) weapons tested functioned normally with the two following exceptions. Round No. 13 failed to fire while employing Weapon No. 2, even though it was subjected to a second hit by the firing pin. Subsequent examination of this weapon revealed that the hammer was being restrained on its forward stroke due to bearing pressure from the side plate. This condition was attributed to an excessive build up of the "Teflon-S" coating on the weapon frame, the side plate, and on both sides of the hammer. Round No 13 was then fired in Weapon No. 1 at which time the primer extruded rearward and prevented cylinder rotation and extraction.

This was the only time cylinder jamming was evident and can possibly be correlated to the fact that the round in question had seen three firing pin hits before firing. A similar failure to fire occurred on Round No. 33 for the same reason with the same weapon. Round No. 33 was subsequently fired in Weapon No. 4 without incident, and the excessive build up of "Teflon-S" was later removed from Weapon No. 2 to remedy the light firing pin hits.

APPENDIX "E"

CERTIFICATION OF ENVIRONMENTAL CONDITIONING OF QSPR REVOLVER AND AMMUNITION

(U) The following is a letter test report on the QSPR revolver and 200 rounds of QSPR ammunition that certifies they were subjected to high humidity, temperature cycling conditioning in accordance with Section 6.2.2 of MTP 4-20-820.

General Testing Laboratories, Inc. / 6840 Industrial Road, Springfield, Virginia 22151 / (703) 354-2000

Hartwood Division
Hartwood, Virginia
22471

LETTER TEST REPORT

DATE: 12 July 1971

BY: Aubrey A. Ellis, Test Engineer

FOR: AAI Corporation
Baltimore, Maryland 21204

TEST ARTICLES: One (1) Smith and Wesson Quiet Special Purpose Revolver, S/N 8319425 and two-hundred (200) rounds of ammunition, 38 Caliber.

SPECIFICATION: AAI Corporation Purchase Order Number 315814 and Aberdeen Proving Ground Material Test Procedure ~~4-2-820~~, paragraph 6.2.2 for Humidity and Temperature Test.

TEST CONDUCTED BY: General Testing Laboratories, Inc.
Pyrotechnic Laboratory
Hartwood Division
Hartwood, Virginia 22471

DATE TEST COMPLETED: 1 June 1971

The pH value of the Chamber (LHHCA/27FS) water supply was determined to be 6.9. The Humidity-Temperature cycle presented in the Table I was repeated ten (10) consecutive times for a total of 240 hours exposure.

TABLE I - HIGH HUMIDITY-TEMPERATURE CYCLE (24 HOURS)

No. of Hours		Temperature, °F (°C)		Relative Humidity, %
2	increase to	105 (40.5)	and	85 to 90
16	maintain at	105 ± 3 (40.5 ± 2)	and	85 to 90
2	decrease	105 to 70 (40.5 to 21)	increase	95 ± 2
4	maintain at	70 ± 3 (21 ± 2)	and	59 ± 2

The Revolver showed no apparent indication of damage and/or deterioration as a result of the test exposure, however, the two hundred (200) rounds of ammunition showed indication of oxidation of the casings.

RECEIVED

1971

Aubrey A. Ellis
Aubrey A. Ellis
Test Engineer

Report No. A-3818

APPENDIX "F"

CERTIFICATION OF ENVIRONMENTAL CONDITIONING OF QSPR AMMUNITION

(U) The following is a letter test report on 75 rounds of QSPR ammunition that certified they were subjected to high humidity, temperature cycling conditioning in accordance with Section 6.2.2 of MTP-4-20-320.

General Testing Laboratories, Inc. / 6840 Industrial Road, Springfield, Virginia 22151 / (703) 354-2000

Hartwood Division
Hartwood, Virginia
22471

LETTER TEST REPORT

RECEIVED
AUG - 4 1971
A.A.I. PROCUREMENT

DATE: 26 July 1971

BY: Steven D. Johnson, Test Technician

FOR: AAI Corporation
Baltimore, Maryland 21204

TEST ARTICLES: Seventy Five (75) rounds of ammunition

SPECIFICATION: AAI Corporation Purchase Order number 317992, MTP-4-2-820, paragraph 6.2.2 for Humidity and Temperature Test.

TEST CONDUCTED BY: General Testing Laboratories, Inc.
Pyrotechnic Laboratory
Hartwood Division
Hartwood, Virginia 22471

REPORT NUMBER: A-3871

DATE TEST COMPLETED: 26 July 1971

Fifty (50) rounds of ammunition were installed into a special holding fixture. Twenty five (25) rounds of ammunition were retained in the standard cardboard container. The seventy five (75) rounds of ammunition were installed into the temperature humidity chamber and subjected to ten (10) continuous cycles of temperature humidity conditions, as described in Table I.

TABLE I - HIGH HUMIDITY-TEMPERATURE CYCLE (24 HOURS)

No. of Hours		Temperature °F (°C)		Relative Humidity, %
2	increase to	105 (40.5)	and	85 to 90
16	maintain at	105 ± 3 (40.5 ± 2)	and	85 to 90
2	decrease	105 to 70 (40.5 to 21)	increase	95 ± 2
4	maintain at	70 ± (21 ± 2)	and	59 ± 2

Post test inspections revealed slight oxidation on the casing of the seventy five (75) rounds of ammunition.

Steven D. Johnson
Test Technician

Report No. A-3871

APPENDIX "G"

(C) QSPR RELIABILITY AND ACCURACY TEST PROGRAM AND EVALUATION (U)

(U) A. Objective

(U) A series of firing tests were conducted by LWL to evaluate the reliability and accuracy of the QSPR and ammunition. The following results and conclusions are included in this appendix:

- Reliability of the weapon and the ammunition.
- The effect of quick versus slow fire on system accuracy.
- Probability of hit (P_H), throughout the range of interest, including comparison with P_H for the caliber .45 pistol and caliber .38 revolver.
- Probability of kill (P_K), throughout the range of interest, including comparison with P_K for the caliber .45 pistol and caliber .38 revolver.

(U) B. Test Procedure

(U) Approximately 400 QSPR rounds were fired during a reliability test program conducted by the Munitions Branch in the LWL test area on Spesutie Island. Prior to the test, a test format (experimental test sequence) for examining the accuracy of firing was provided by the Research Analysis Office (RAO). This format consisted of individual firing tests which were designed to provide information on the effects of quick vs. slow fire, single-action vs. double-action trigger pull, single-round firing vs. two-round firing, and the effects of range.

(U) The RAO accuracy test was superimposed on the reliability test.

(U) Two firers were provided by the Military Operations Division (MOD) of LWL for the test. Both firers were pistol-qualified. Two firing positions were established, one at five meters from the target and one at 15 meters from the target. The positions were determined such that the distance from the end of the barrel (with the weapon held in the firing position) to the target was the indicated range. For the slow-firing salvos, the firer was allowed all the time he desired before firing. The quick-fire sequence was implemented using a retractable muslin screen, where the silhouette target (face-on, head and shoulders) was placed at various positions on a vertical 4' x 8' plywood sheet and the specific positions were unknown to the firer prior to uncovering the target. The muslin screen was uncovered for a period of one to three seconds and then dropped back to cover the target area. The times of target exposure were varied to reduce the tendency of the firer to depend upon a full three-seconds target exposure. For all firings (entire test), the target silhouettes had no center markings and the firer was instructed to aim at the center of mass of the silhouette.

(U) Data was collected in accordance with the prescribed format. This consisted principally of measuring the coordinates of impact for each pellet in each salvo. Since no center markings were used, the lower left hand corner of the silhouette was taken as reference.

(U) From the measured coordinates of impact for each pellet in each salvo, the center of impact of each salvo was calculated by determinig the mean horizontal and vertical impact coordinates. It was then assumed that these mean impact coordinates represented the aiming point for the particular

salvo. The aiming error distribution was then estimated by calculating the standard deviation of the horizontal and vertical mean impact coordinates for all replications of the same test conditions.

(C) C. Reliability of the Weapon and Ammunition

(C) 1. Weapon

(C) Four (4) different weapons were used, identified as weapons Nos. 2, 3, 5 and 6. The log entries indicate that only one (1) weapon malfunction occurred and this was recorded on Salvo No. 127 as a " . . . . hammer jam on second round (roll past)".

(C) The following table can be constructed from the firing lot:

Weapon	Number of Trials (2)	Number Mal[illegible]ions (3)	[illegible] $\frac{(3)}{(2)}$
2	102	1	1/102
3	93	0	0/93
4	73	0	0/73
5	124	0	0/124
Aggregate	392	1	1/392

(C) Table I. QSFR Weapon Reliability Data (U)

(C) In constructing Table I, misfires attributed to ammunition malfunction are included in the number of trials. Reliability calculations based upon the entries of Table I and a 95% confidence interval yield the following:

Weapon	Reliability
2	.9544
3	.9683
5	.9598
6	.9762
Aggregate	.9880

(C) Table II. Weapon Reliability @ 95% Confidence (U)

(C) 2. Ammunition

(C) In 382 trials ten (10) ammunition malfunctions were recorded. All of the malfunctions occurred when cycled ammunition was used. Furthermore, from the no-fire log of Reference 1 six (6) of the ten (10) misfires are attributed to the second can of cycled ammunition which was used.

(C) Data for the reliability calculations has been extracted from the firing log and is presented in the table below.

Ammunition Condition		Number of Trials (2)	Number of Malfunctions (3)	Ratio $\frac{(3)}{(2)}$
Cycled	Container 1	89	4	4/89
	Container 2	21	6	6/21
Uncycled	Lot	272	0	0/272

(C) Table III. QSPR Ammunition Reliability Data (U)

(C) Reliability calculations based upon the entries of Table III and a 95% confidence interval yielding the following:

Ammunition Conditioned		Reliability
Cycled	Container 1	.9001
	Container 2	.5172
Uncycled	Lot	.9890

(C) Table IV. Ammunition Reliability @ 95% Confidence (U)

(C) D. The Effect of Quick vs. Slow Fire on System Accuracy (Reference 2)

(C) 1. Aiming Error

(U) The coordinates of impact for each pellet in each salvo were measured and the center of impact of each salvo was calculated by determining the mean horizontal and vertical impact coordinates. It was then assumed that these mean impact coordinates represented the aiming point for the particular salvo. The aiming error distribution was then estimated by calculating the standard deviation of the horizontal and vertical mean impact coordinates for all replications of the same test conditions.

(C) The results of the accuracy test are given below.

(C) (1) Five meters range, single-action and double-action trigger pull - The nominal firing conditions were at five meters range in the slow-fire and single-round mode; that is, the bulk of the tests were for these conditions. Each subject fired 32 rounds each in the single-action and double-action condition. The results are as follows (table entries are in mils):

Firer	Action	Horizontal		Vertical	
		Mean	Std Dev	Mean	Std Dev
Cloutier	Single	-7.1	10.3	-10.9	16.2
	Double	-7.8	13.9	-10.0	19.3
Gunter	Single	-7.2	15.3	-11.1	29.1
	Double	+9.6	16.7	- 0.6	19.7

(C) (2) Fifteen meters range - each subject fired 16 rounds under controlled test conditions in the single-round, single-action, slow-fire condition. The results are as follows (table entries are in mils):

Firer	Horizontal		Vertical	
	Mean	Std Dev	Mean	Std Dev
Cloutier	+1.8	6.3	+6.9	8.1
Gunter	+1.9	10.5	+5.9	13.8

(C) (3) Five meters range, quick-fire, single-round salvo - Each subject fired a total of 16 rounds in the quick-fire condition. Eight rounds were fired in the single-action and eight rounds in the double-action condition. The results are as follows (table entries are in mils):

Firer	Action	Horizontal Mean	Horizontal Std Dev	Vertical Mean	Vertical Std Dev
Cloutier	Single	-10.2	19.9	0.9	13.6
	Double	- 0.1	13.0	-14.0	17.9
Gunter	Single	14.0	17.2	-12.2	38.3
	Double	38.5	20.8	- 9.4	40.3

(C) (4) Five meters range; quick-fire, double action, two-round salvo - Each subject fired 16 salvos of two rounds each. For the two-round salvos, the centers of impact were determined in the same manner as for the one-round salvo. The results are as follows (table entries are in mils):

Firer	Horizontal Mean	Horizontal Std Dev	Vertical Mean	Vertical Std Dev
Cloutier	9.6	10.0	16.1	17.1
Gunter	18.1	10.3	27.6	28.8

(U) It is clear from Table V that there are six (6) test combinations to be compared. The aiming error distribution is assumed bivariate normal; however, by inspection it is non circular. The effect of test combination on system accuracy can be ranked by computing the equivalent circular probable error to each non-circular distribution and ordering. While the CEP, as a parameter, is not associated with the non-circular bivariate normal distribution, there is a circle centered at the aiming point of that distribution which contains half of the impact points. While it is not valid to use this "equivalent CEP" to compute hit probabilities, it is an expedient measure of goodness. We will make the implication that small is good, smaller is better, and smallest is best.

No. of Rounds in Salvo		One-Round Salvo										2 Round Salvo	
Range		5 Meters								15 Meters		5 Meters	
Fire Control		Slow				Quick				Slow		Quick	
Trigger Action		Single		Double		Single		Double		Single		Double	
Aiming Errors* (mils)		σ_x	σ_y	σ_x	σ_y	σ_x	σ_y	σ_x	σ_y	σ_x	σ_y	σ_x	σ_y
FIRER	Cloutier	10.3	16.2	13.0	19.3	14.9	13.4	15.0	17.9	6.3	8.1	10.1	17.1
	Gunter	15.3	28.1	16.7	19.7	17.4	30.3	20.8	40.3	10.5	13.8	10.3	28.8
Test Combination		1		2		3		4		5		6	

* Table entries are one linear standard deviation.

(C) Table V. Summary of Aiming Errors, QSPR (U)

Firer	Test Combination	$\frac{\sigma_{min}}{\sigma_{max}}$	$\frac{R}{\sigma_{max}}$	σ_{max}	R
Cicutker	1	.635	.956	16.2	15.487
	2	.720	1.012	19.3	19.531
	3	.673	.980	19.9	19.502
	4	.726	1.014	17.9	18.151
	5	.777	1.044	8.1	8.456
	6	.384	.924	17.1	15.800
Gunter	1	.525	.886	29.1	25.782
	2	.847	1.088	19.7	21.434
	3	.449	.840	38.3	32.172
	4	.516	.880	40.3	35.460
	5	.761	1.036	13.8	14.290
	6	.358	.784	28.8	[illegible].579

(C) Table VI. Equivalent CEP's (R's) of Test Combinations (U)

(U) The radius of the circle, R, in Table VI above is computed using Figure 1 "Equivalent CEP Chart" of Reference 3.

(U) It can be inferred from the above results that one of the largest factors influencing accuracy is the difference in firers. An examination of learning effects on accuracy shows that both firers improved considerably during the course of the tests; however, due to the limited sample sizes, it is not prudent to extrapolate accuracy estimates for a fully trained firer.

(U) A second factor influencing accuracy is the lack of a designated target center (bulls-eye). This conclusion is fairly obvious when the five-meter and 15-meter results are compared. The explanation is similarly obvious in that, principally, the results are contingent on the relative proportions of the sight picture to the target. Moving the target further away has the effect of enabling the firer to better discriminate between the center of mass and the center of the target picture.

(U) It should be clear that at very close ranges it is virtually impossible, or at least very difficult to discern the center of target mass, while at the longer ranges the exercise becomes a practicality - especially if the firer has a reasonable amount of "time on target". The confounding afforded by stress and varying target exposure times particularly at the closer ranges, inflate the aiming errors.

(U) The effect of slow versus quick fire is very clear, and can be safely compared on the basis of agreement in performance trends when the test parameter fire control is changed from slow to quick while holding range and trigger action constant. Both firers obtain better (smaller) circles on slow fire, single action at five (5) meters. The glaring improvement at fifteen meters by both firers has been previously explained.

(C) 2. Ballistic Dispersion

(C) The test provided an opportunity to estimate the pellet dispersion based on a large number of firings. The results of the dispersion estimates for one-round salvos are given below (table entries are in mils and represent one linear standard deviation):

Firer	5 Meters		15 Meters	
	Horizontal	Vertical	Horizontal	Vertical
Cloutier	5.9	6.4	7.0	6.9
Gunter	6.0	6.5	6.7	8.5

(C) The results above may be combined to give an estimated CEP of 7.3 mils at five meters range and 8.6 mils at 15 meters range. Alternatively, the estimated average extreme spread in both the horizontal and vertical directions for a 15-pellet salvo is 21.5 for five meters range and 25.4 mils for 15 meters range.

(C) E. QSPR Hit Probability (P_H) and Comparison with P_H for the Caliber .45 Pistol and the Caliber .38 Revolver

(U) The Frankford Arsenal (F/A) salvo kill probability model was exercised to obtain hit probability for the weapons and ranges of interest. The salvo kill model assumes a bivariate normal distribution of both aiming and ballistic errors. The model assumes square targets to take advantage of computational symmetry. A single or line (squad) target may be analyzed. In this investigation a single target was analyzed. Principal required inputs to the program are:

- Aiming errors
- Ballistic errors
- Aim point
- Number of projectiles in salvo
- Attendant projectile characteristics (Wt., size, etc.)

(U) The aim point was taken at the center of the target to be consistent with the test directive - "aim at the center of mass". Aiming and ballistic errors are taken from the previous section for the QSPR and from the tables below for the caliber .45 pistol and the caliber .38 revolver, with noted exception.

Fire Control		Slow				Timed	
Source		Md. State Police		[illegible]		[illegible]	
		σ_x	σ_y	σ_x	σ_y	σ_x	σ_y
Trigger Action	Single	1.9	2.3	5.7	5.7	6.4	10.9
	Double	2	2				

*Table entries are one linear standard deviation.

(C) Table VII. Aiming Error Data for the Caliber .38 Revolver (U)

Personnel	Aim Error	
	σ_x	σ_y
Civilian	3.5	3.7
Military	8.7	8.0

*Table entries are one linear standard deviation.

(C) Table VIII. Aiming Error Data for the Caliber .45 Pistol (U)

Ranges of interest were 3 meters and 15 meters.

(C) By way of comparison a 9.5 mil aim error is cited in Reference 4 for the caliber .45 pistol and proficient firers with a three (3) second target exposure time. This is slightly larger than the error data of Table IX which was obtained from Edgewood Arsenal. For purposes of this evaluation the 9.5 mil error was used for "quick-fire" aiming error (QSPR tests allowed maximum of three (3) seconds per target in the quick fire mode). To promote consistency in the evaluation the timed fire aiming errors of the caliber .38 revolver are assumed synonomous with quick fire errors. Errors for the slow fire condition are broken into the dichotomy of civilian personnel and military personnel for both the caliber .38 revolver and the caliber .45 pistol.

(C) Ballistic dispersion is approximately the same for both the caliber .38 and caliber .45 bullet. For this investigation the value used was $\sigma_x = \sigma_y = 1$ mil.

(C) Results of the hit probability investigation are shown in Table IX.

Weapon	Aim Error (mils)		Ballistic Error (mils)		P_H		Remarks
	σ_x	σ_y	σ_x	σ_y	5 Meters	15 Meters	
QSPR	10.3	16.2	6.0	6.5	.99997	.94601	slow fire, single action
	13.9	19.3			.99985	.87212	slow fire, double action
	19.9	13.4			.99976	.86107	quick fire, single action
	13.0	17.9			.99993	.90392	quick fire, double action
	15.3	29.1			.99003	.69135	slow fire, single action
	16.7	19.7			.99980	.82934	slow fire, double action
	17.2	38.3			.95074	.54814	quick fire, single action
	20.8	40.3	6.0	6.5	.93810	.48760	quick fire, double action
[illegible]	1.9	2.3	1.0	1.0	.99999	.99999	slow fire, civilian
	5.7	5.7			.99999	.99954	slow fire, military
	6.4	10.9	1.0	1.0	.99998	.94980	quick fire
.45	3.5	3.7	1.0	1.0	.99999	.99998	slow fire, civilian
	8.7	8.0			.99999	.97834	slow fire, military
	9.5	9.5	1.0	1.0	.99999	.95190	quick fire

(C) Table IX. Summary of Weapon Error Data and Attendant Hit Probabilities (U)

(C) F. QSPR Kill Probabilities (P_K) and Comparison with P_K for the Caliber .45 Pistol and the Caliber .38 Revolver

(U) The Frankford Arsenal salvo kill probability model was exercised to obtain kill probabilities for the weapons and ranges of interest. Since this would be a head-to-head comparison between weapons, the selection of a particular stress situation is academic. Ordered results would remain unchanged regardless of the selection.

(C) The 30 second assault criterion was used. It gives reasonably large conditional kill probabilities, P_{HK} (helpful when looking for small differences), while representing fairly a stress situation for pistol or revolver employment. A summary of results for the kill probability investigation is given in Table X. Additional inputs needed for the kill probability model are as follows:

Weapon	Muzzle Velocity (ft/sec)	Projectile Weight (grains)	No. of Projectiles in Salvo
QSPR	700	7.5	15
Cal. .38 Revolver	855	158	1
Cal. .45 Pistol	850	230	1

(C) The results of the P_K investigation are easily interpreted.

- The kill probability of the QSPR is higher at 5 meters than either the caliber .38 revolver or the caliber .45 pistol, and this is shown to be true for all aiming errors computed for the QSPR test conditions.

- If the errors of the better of the two shooters of the QSPR test program are used and a one-to-one correspondence of test conditions and available caliber .38 and .45 data are compared, then again the QSPR exhibits considerably more kill probability at the 15 meters range.
- In short the QSPR offers considerable lethality improvement over both the caliber .38 revolver and the caliber .45 pistol inside the ranges of interest.

Weapon		Aim Error (mils) σ_x	Aim Error (mils) σ_y	Ballistic Error (mils) σ_x	Ballistic Error (mils) σ_y	P_K 5 Meters	P_K 15 Meters	Remarks
QSPR	Firer #1	10.3	16.2	6.0	6.5	.99997	.94607	slow fire, single action
		13.9	19.3			.99985	.87222	slow fire, double action
		19.9	13.4			.99976	.86118	quick fire, single action
		13.0	17.9			.99993	.90391	quick fire, double action
	Firer #2	15.3	29.1			.99005	.69148	slow fire, single action
		14.7	19.7			.99980	.82947	slow fire, double action
		17.2	38.3			.95083	.60644	quick fire, single action
		21.8	40.3	6.0	6.5	.93817	.48773	quick fire, double action
.38		1.9	2.3	1.0	1.0	.75771	.75771	slow fire, civilian
		5.7	4.7			.75771	.75736	slow fire, military
		6.4	10.9	1.0	1.0	.75771	.71967	quick fire
.45		3.5	3.7	1.0	1.0	.81773	.81772	slow fire, civilian
		4.7	8.0			.81772	.80002	slow fire, military
		9.5	9.5	1.0	1.0	.81772	.77340	quick fire

(C) Table X. Summary of Weapon Error Data and Attendant Kill Probabilities

REFERENCES

1. Log and Data Book, LWL Environmental and Accuracy Tests of QSPR.

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13. ABSTRACT

ABSTRACT

(U) The LLL Tunnel Weapon was evaluated in the Republic of Viet Nam, ~~during July through October [illegible]~~. The results of this evaluation indicated that the weapon system was well received primarily because the low firing noise permitted use of the weapon without giving away the [illegible]'s position. In addition to its tunnel exploration role, the weapon was used in ambush situations and in search and destroy operations. Because of this, the weapon is now designated the Quiet, Special-Purpose Revolver (QSPR).

(U) Before consideration could be given to quantity procurement, it was necessary to correct any weapon and ammunition deficiencies noted during the RVN evaluation, particularly those reported as ammunition misfires.

(U) The objectives of this program were to determine the causes of misfires and malfunctions of the Quiet, Special-Purpose Revolver and its associated low signature, multi-projectile ammunition, to modify or redesign components to effect necessary corrections including testing of all components to assure reliability of corrective action; and to modify weapons and fabricate ammunition for reliability testing by USALWL.

(U) The effort expended under this contract revealed that the major causes of the misfires were the marginal firing pin energy and the combination anvil-primer design of the ammunition. A secondary or helper spring was added to the weapon's main spring that provided a 10% increase in firing pin energy and eliminated mainspring degradation. The ammunition was redesigned with fewer parts and the primer was repositioned and exposed at the base of the round for direct contact by the firing pin as in conventional ammunition. These design improvements resulted in not a single misfire throughout the development, assurance, and acceptance tests associated with this program.

(U) Numerous other design improvements were incorporated into the weapon, ammunition and holster assembly. At the completion of the program, improved weapons, improved holster assemblies, and improved ammunition complete with packaging were delivered for further user tests.

(U) A series of firing tests were conducted by LWL to evaluate the reliability and effectiveness of the QSPR and ammunition. Analyses of the data showed the reliability of the weapon and ammunition to be excellent at this stage in the development and that the QSPR offers considerable lethality improvement over both the caliber .38 revolver and the caliber .45 pistol inside the ranges of interest.

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Reduced Noise						
Reduced Flash						
Hand Held Weapon						
Effectiveness						
Ambush						